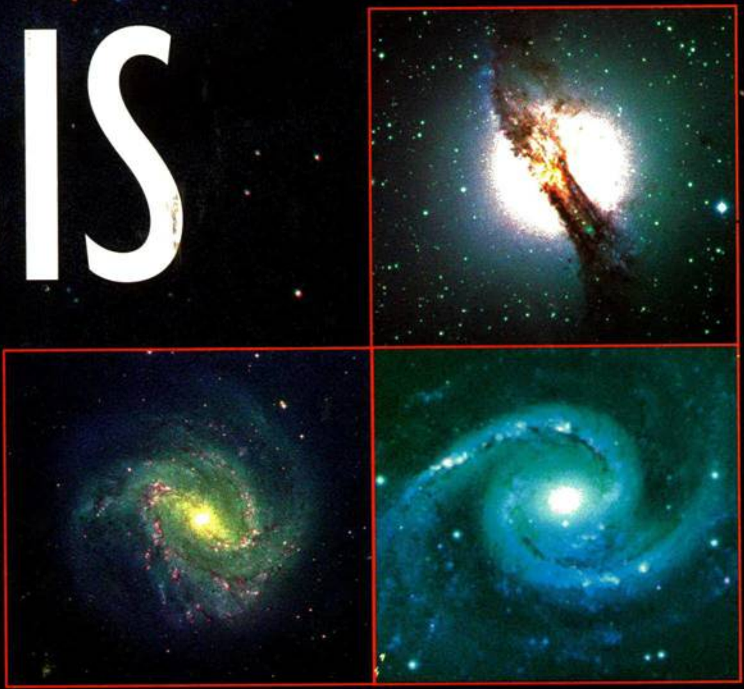
SPECIAL EDITION ON GALAXIES

Astronomy®

HDG 08070

May 1999 • $4.50
U.K. £2.40
Can. $5.75

THE STORY OF GALACTIC GENESIS



How Our Galaxy Grew Up

Black Hole Hunters

Clusters in Collision

Plus:

Make Your Own Milky Way

Loving the Moon's Landscape

MEADE ETX-90/EC

Now, ETX pushbutton electronic control — for only *$595* complete!

Already the largest-selling modern telescope in the world, the Meade ETX has been re-engineered for 1999 to provide the very latest in microprocessor-controlled capability.

New Fork Mount Design with Standard-Equipment Dual-Axis Drive System: The ETX-90/EC's fork mount includes high-torque DC motors on both telescope axes, permitting electronic operation from the standard-equipment plug-in hand controller.

Pushbutton Electronic Hand Controller: Use the hand controller at any of four dual-axis speeds: 8x for image centering in the main telescope at high power; 32x for image centering at lower power or for pushbutton object-tracking in the altazimuth mode; 0.75°/sec for image centering in the viewfinder or for terrestrial tracking; 5°/sec for fast slewing across the sky.

Cordless Operation: The dual-axis drive system operates for more than 40 hours from eight (user-supplied) AA batteries which store neatly inside the drive base. Or use the optional 25 ft. auto cigarette lighter cord that plugs into the telescope's control panel.

Optional Autostar™ Capability: Plug in the optional Meade Autostar computer controller *(see facing page)* for LX200-type operation, including automatic GO TO capability to more than 12,000 celestial objects.

Plus the features that created the ETX revolution:

Maksutov-Cassegrain Optical System: Manufactured at the Meade Irvine, California facility, ETX diffraction-limited optics produce images so high in contrast, brightness, and resolution that the ETX consistently outperforms telescopes of larger apertures.

Flip-Mirror System: Flip the internal optical flat mirror "up" for 90° observing; flip the mirror "down" for terrestrial observing with the optional #932 45° Erecting Prism or for photography with the optional #64 Photo Adapter.

SPECIFICATIONS: ETX-90/EC Astro Telescope — Includes Maksutov-Cassegrain optical tube assembly (D = 90mm, F = 1250mm, f/13.8) with EMC super multi-coatings; internal flip-mirror system for either straight-through or 90° observing position; fork mount with electric slow-motion controls, setting circles and locks on both axes; electronic control panel; 4-speed (8x, 32x, 0.75°/sec, 5°/sec) dual-axis motor drive system with hand controller; sidereal-rate tracking in equatorial mode with optional table tripod or deluxe field tripod; internal battery compartment accepting eight (user-supplied) AA-size batteries; 8 x 21mm erect-image viewfinder; Series 4000 Super Plössl 26mm eyepiece (1.25"); operating instructions. Net weight 9 lbs. — **$595** (+ $20 P & S).

COMPUTER CONTROL
AUX
HBX
ON
OFF
12v
AUX
MEADE
IN
FOCUS
OUT
SPEED
MODE
MEADE

Meade ETX-90/EC: complete as shown, with electronic hand controller... **$595**
(+ $20 packing & shipping in the 48 states)

OPTIONAL SYSTEMS FOR ETX-90/EC

#497 Autostar Computer Controller	$149.00
#880 Equatorial Table Tripod	29.95
#883 Deluxe Full-Length Field Tripod	199.95
#825 8 x 25mm Right-Angle Viewfinder	49.95
#774 Hard Carry Case	99.95
#932 45° Erecting Prism	49.95
#64 Photo Adapter	34.95
#1244 Electric Focuser, plugs into control panel	119.95

AUTHORIZED MAIL-ORDER DEALERS:

ASTRONOMICS, Norman, OK.
Orders: 800-422-7876; Info.: 405-364-0858.

FOCUS CAMERA, Brooklyn, NY.
Orders: 800-221-0828; Info.: 718-436-6262.

LUMICON, Livermore, CA.
Orders: 800-767-9576; Info.: 510-447-9570.

OCEANSIDE PHOTO & TELESCOPE, Oceanside, CA.
Orders & Information: 800-483-6287.

POCONO MOUNTAIN OPTICS, Moscow, PA.
Orders: 800-569-4323; Info.: 717-842-1500.

RIVERS CAMERA, Dover, NH.
Orders: 800-245-7963; Info.: 603-742-4888.

SHUTAN CAMERA & VIDEO, Chicago, IL.
Orders & Info.: 800-621-2248; IL: 312-332-2000.

KHAN SCOPE CENTRE, Toronto, Ontario, Canada
Orders & Information: 416-783-4140.

Add the Meade Autostar™ hand controller to your ETX-90/EC for fully automatic GO TO object location

...only *$149!*

ETX AUTOSTAR
RA = 08:04.6
Dec = +36°38
MEADE
ENTER
MODE
GO TO
1
2
3
4
5
6
7
8
9
0
?

The Meade #497 Autostar Computer Controller *(shown actual size)* plugs in directly to the control panel of the Meade ETX-90/EC and permits LX200-type automatic object location from a 12,000-object database, a database that includes virtually every astronomical object visible with the ETX-90/EC telescope. **$149.**

Plug the #497 Autostar Computer Controller into your ETX-90/EC and you're ready for an incredible array of LX200-type capabilities:

Automatic dual-axis GO TO function at 5°/sec to any of more than 12,000 database objects, including deep-space objects (galaxies, diffuse nebulae, planetary nebulae, star clusters — the best objects from the IC, NGC and Caldwell catalogs, as well as all 110 Messier objects); 900 stars (double stars, variable stars, SAO stars); the 8 major planets from Mercury to Pluto; 26 of the brightest asteroids; 15 periodic comets; 50 earth-orbiting satellites; plus user-defined objects and the centroids of all 88 constellations. Select any of these objects, press ***GO TO*** and the telescope automatically slews to the object, placing it in the telescopic field.

Automatic GO TO function to *any* object of known R.A. and Dec.

Digital readouts of telescope position (continuously in R.A. and Dec.), menu options, glossary, and utility functions.

Precise sidereal-rate tracking in either altazimuth or equatorial modes. For altazimuth tracking, set the telescope on its drive base and perform a quick, easy alignment.

9-Speed Dual-Axis Operation: Pushbutton operation of the telescope on both axes, simultaneously, at any speed from 2x sidereal to 5°/sec.

RS-232 Serial Port: For operation of the telescope through a personal computer, using Meade Epoch 2000 sky software or programs of the user's own writing.

Plus: over 20 other menu options, including guided tours, major event menus, user-defined terrestrial objects, and much more.

MEADE
COMPUTER CONTROL
MEADE

(right) **Meade ETX-90/EC,** shown with optional #497 Autostar Computer Controller plugged into the telescope's control panel.

Write, call, or fax Meade Instruments for your free copy of the 100-page Meade General Catalog.

Prices shown are suggested U.S. mail-order retail prices.
Patents pending on ETX-90/EC and Autostar.

ADVANCED PRODUCTS DIVISION
Meade Instruments Corporation
The largest-selling telescopes in the world. ☐ *A Nasdaq company.*
6001 Oak Canyon, Irvine, California 92620 ☐ (949) 451-1450
FAX: (949) 451-1460 ☐ *www.meade.com*

© 1999

May 1999 • Vol. 27, No. 5

Astronomy®

COVER PHOTOS: David Malin/Anglo-Australian Telescope Board

FEATURES

COVER

38 Galactic Genesis

Seventy-five years after Edwin Hubble deduced the nature of galaxies, astronomers still debate how they form and evolve. *David J. Eicher.*

48 Black Hole Hunters

Meet the people who search the centers of galaxies for the supermassive black holes that power quasars, blazars, and the like. *Steve Olson.*

56 A Googolplex of Galaxies

Hundreds of billions of stars form a galaxy, and 100 billion galaxies stretch across 100 billion trillion miles. When it comes to the universe, big numbers rule. *John P. Wiley, Jr.*

58 Clusters in Collision

Witness the carnage as large galaxies devour small in the packed confines of big clusters. *David Graham.*

64 Let There Be Light

The early months of 1999 saw two new 8-meter telescopes join the other giants atop Mauna Kea in Hawaii. *Kelly Whitt.*

78 Spirals and Giants and Dwarfs Oh My!

The spring sky offers galaxies for every observing taste, from bright sentinels in the nearby universe to colliding pinwheels and huge clusters far away. *Steve Gottlieb and Richard Jakiel.*

86 Exploring Crater Rays

Born in the aftermath of enormous impacts, the bright lunar crater rays attest to the solar system's violent history. *Jim Bell.*

92 Kids' Corner: Home Spiral

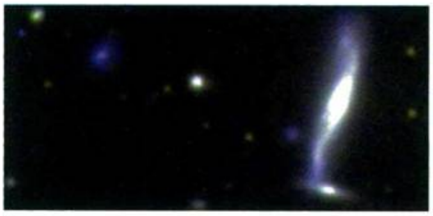
While the starry band of the Milky Way blazes in a dark sky, use it as a visual tool for learning about our galaxy and others. *Andrea Gianopoulos.*

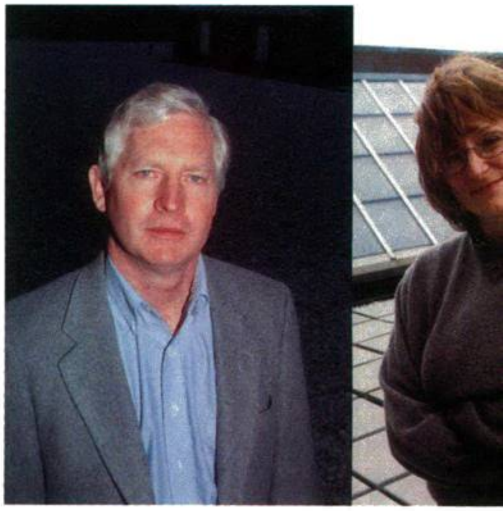
78 Spirals and Giants and Dwarfs

Martin Germano

58 Clusters in Collision

William C. Keel (Univ. of Alabama)





38 The Story of Galactic Genesis

David Malin/Anglo-Australian Telescope Board

DEPARTMENTS

22 AstroNews Hubble Heritage Team (AURA/STScI/NASA)

6 Behind the Scenes
- A Visit to *The X–Files*

18 Talking Back

22 AstroNews
- A Burst Like No Other
- Possible Earth-mass Planet Found
- Message in a Bottle
- Japanese Mars Probe Delayed
- Eros Revealed
- Faster than Light
- The Disks of Taurus
- View of a Supernova Remnant
- Looking for Ghosts
- SOHO Back in Business

66 Sky Show
- While Mars and Venus continue to blaze in the evening sky, diminutive Pluto glows at its brightest for 1999. *Martin Ratcliffe and Alister Ling.*

96 Ask Astro

106 Star Stuff

Products
- Interactive Astronomy
- Seasonal Star Hopping
- QuikFinder

Books
- *Worlds Without End: The Exploration of Planets Known and Unknown*
- *The Celestial River*
- *Wishbone: Unleashed in Space*
- *40 Nights to Knowing the Sky*

Bytes
- Touring the Universe Through Binoculars Star Atlas

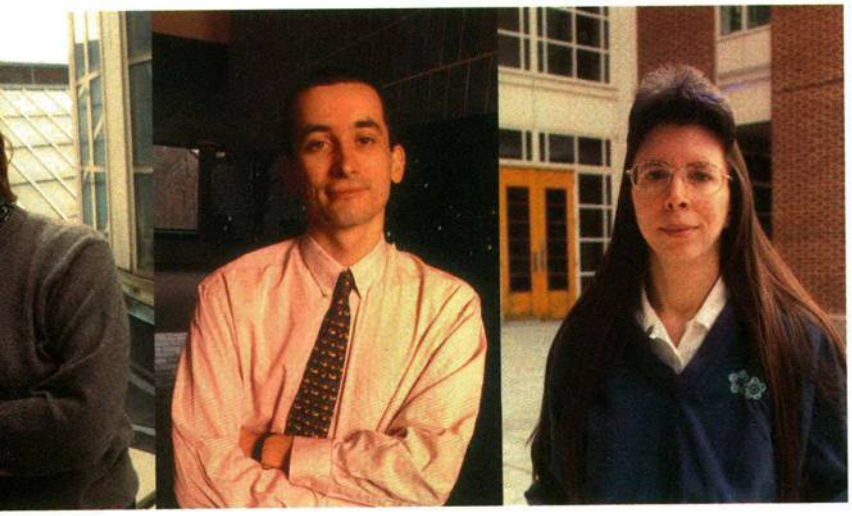
116 Looking Ahead

123 Advertiser Index

124 Hot Shots
- Seven Hours on Mauna Kea

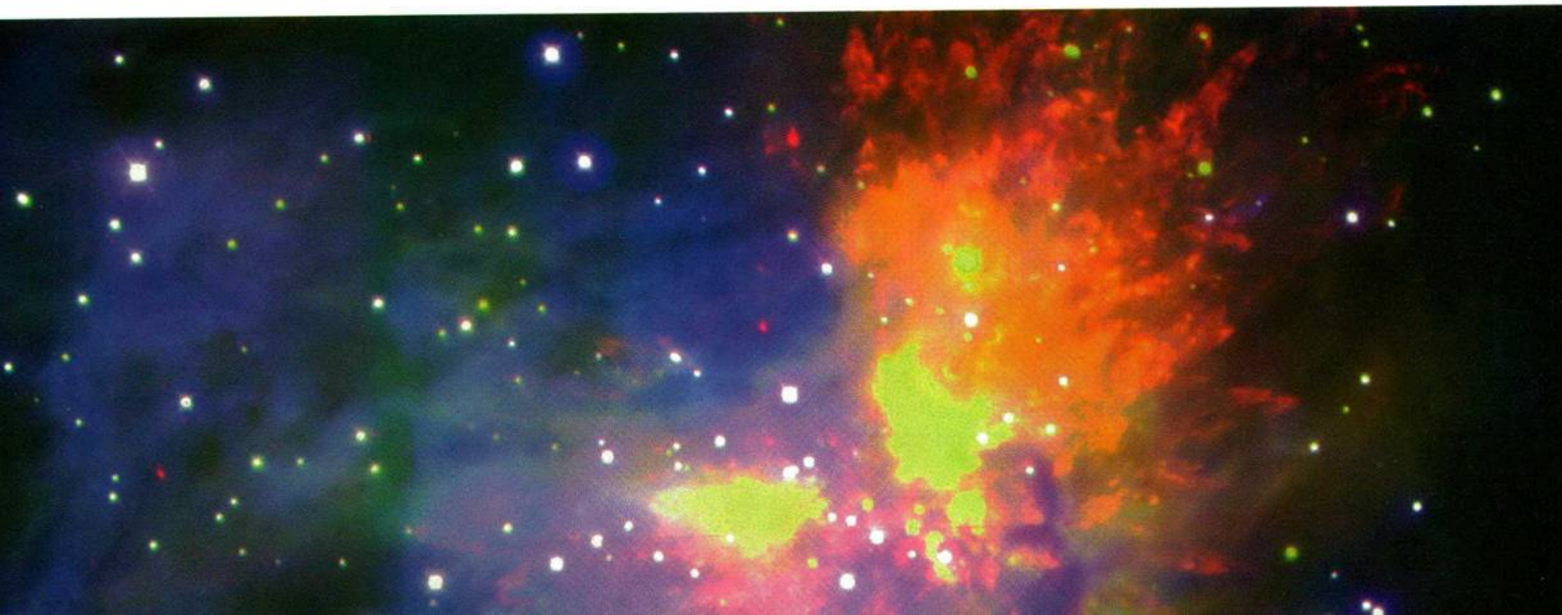
130 Ultimate Exposure

48 Black Hole Hunters Laura Miller



96 Ask Astro *Astronomy*: Terri Field

64 Let There Be Light Subaru Telescope, NAOJ



BEHIND THE SCENES

BY BONNIE BILYEU GORDON

A Visit to *The X-Files*

Last year I got a call from Matt Amato, a production assistant with *The X-Files* television series. He asked if he could get copies of *Astronomy* magazine to use as set dressing for the show. Since then he has called again for *Astronomy*'s help. Once he wanted permission to use our cover bearing a portrait of an actor who would be playing a physicist in the series. We said yes. A day later he called again to say he couldn't use *Astronomy* because "Our physicist is the wrong kind of physicist." The character was to be a nuclear physicist who specialized in putting small lethal machines inside people. When his face finally appeared on the show, it was on the cover of the respected weekly journal *Science* instead.

Canada Gordon

Alien baby props offered extra appeal.

The next time Matt called he wanted to get enlargements of the images we run in the magazine. These would be used to decorate *X-Files* character Fox Mulder's apartment. (It seems that Mulder has been a serious astronomy buff since childhood. This interest may even have preceded the abduction of his sister by aliens.) I sent Matt to NASA websites, and now enlargements of Hubble images appear on the walls of Mulder's apartment, which is supposed to be in Alexandria, Virginia.

Only it isn't. I was in his apartment last month. It's in Studio 6 at one of the Fox production lots in Los Angeles. In some mysterious convergence, my daughter Canada found a job at *The X-Files* with props master Tom Day. I was in California so she invited me over to look at the sets — and maybe sneak a peek at a shoot. I hit just the right day and was able to watch the company film an appealing snippet with David Duchovny as Mulder preparing for bed. Still, for me, the best part of the visit was drifting around, recognizing many of the rooms that figure regularly in *The X-Files* — and finding *Astronomy* in both Mulder's office and his living room. The bulletin board in Fox's FBI office was graced with two images from the pages of *Explore the Universe*, our annual publication.

I had been in Anaheim five days for the annual meeting of the American Association for the Advancement of Science, listening mainly to cosmology papers. A glimpse into the lighter world of television was something I needed. Meanwhile, here in Wisconsin, the other *Astronomy* editors were working diligently to put out perhaps our most important issue of the year, one focused on the beginning, evolution, and future of galaxies. The project was managing editor David Eicher's idea, and he worked especially hard to pull it off. Look almost anywhere in May's *Astronomy* and you will find Galaxy Specials.

Astronomy®

EDITORIAL STAFF

EDITOR
Bonnie Bilyeu Gordon
MANAGING EDITOR
David J. Eicher
SENIOR EDITOR
Rex Graham
ASSOCIATE EDITORS
Andrea Gianopoulos, Robert Naeye, Tracy Staedter, Richard Talcott
COPY EDITOR
Kelly Kizer Whitt
EDITORIAL ASSISTANT
Terry Williams Conley
EDITORIAL SECRETARY
Julie Sherwin
CONTRIBUTING EDITORS
Ray Jayawardhana, Patricia Kurtz, Beth Livermore, John Shibley, Tom Yulsman

ART STAFF

ART DIRECTOR
Carole Ross
ASSISTANT ART DIRECTOR
Thomas Ford
ILLUSTRATORS
Elisabeth Rowan and Terri Field
PRODUCTION COORDINATOR
Helene Tsigistras

EDITORIAL ADVISORY BOARD

Buzz Aldrin, Marcia Bartusiak, Timothy Ferris, Paul Hodge, John S. Gallagher III, Anne L. Kinney, Edward Kolb, Alan Lightman, Stephen P. Maran, Boyce Rensberger, James Trefil

PUBLISHER

Russell G. Larson

Astronomy **HOME PAGE**
http://www.astronomy.com

Astronomy (ISSN 0091-6358, USPS 531-350) is published monthly by Kalmbach Publishing Co., 21027 Crossroads Circle, P.O. Box 1612, Waukesha, WI 53187. Editorial phone: (414) 796-8776; advertising: (800) 558-1544; customer service: (800) 446-5489; subscriptions: (800) 446-5489, Monday through Friday, 8:30 A.M. to 5 P.M. CT, fax (414) 796-0126.

Copyright © 1998 Kalmbach Publishing Co., all rights reserved. Material in this publication may not be reproduced in any form without permission.

Periodicals postage paid at Waukesha, WI, and additional offices. Printed in the U.S.A. Allow 6 to 8 weeks for new subscriptions and address changes. *Subscription price:* 1 year $39.95, Canadian and foreign: 1 year $50, payable in U.S. funds (Canadian price includes GST). BN 12271 3209 RT. Canada Post Publication Agreement Number 545-775. Not responsible for unsolicited materials. POSTMASTER: Send address changes to *Astronomy*, 21027 Crossroads Circle, P.O. Box 1612, Waukesha, WI 53187-1612.

MEADE
Model 203SC/300: 8" f/10 Schmidt-Cassegrain Telescope
$795
(+ $65 packing and shipping in the 48 states)
(shown with optional #1702 Drive System)
Model 203SC/500: 8" f/10 Schmidt-Cassegrain Telescope
$895
(+ $65 P & S)
Model 102ACHR/300: 4" f/9 Achromatic Refracting Telescope
$595
(+ $55 P & S)
Model 102ACHR/500: 4" f/9 Achromatic Refracting Telescope
$695
(+ $55 P & S)
MEADE 203/SC EMC

LXD 300

Now you can buy a Meade® 8" f/10 Schmidt-Cassegrain Telescope, complete with LXD 300 equatorial mount, rigid full-length aluminum tripod, and accessories for only $795! Or a Meade 4" f/9 Achromatic Refractor, complete, for only $595!

Choose either the Meade 203SC/300, with the exact same optical tube assembly as more expensive Meade 8" Schmidt-Cassegrains, or the Model 102ACHR/300 with its exquisite 4" Meade air-spaced achromatic lens. Both telescopes are equipped with the high-performance Meade LXD 300 equatorial mount with dual-axis aluminum worm gears.

SPECIFICATIONS: Models 203SC/300 and 102ACHR/300 — Each telescope includes 8" f/10 Schmidt-Cassegrain *or* 4" f/9 Achromatic Refractor optical tube assembly with EMC super multi-coatings; LXD 300 equatorial mount with aluminum worm gears, micrometric manual slow-motion controls, and setting circles on both axes; manual control for azimuth alignment; elevation control and scale for polar alignment at latitudes from 15° to 50°; adjustable full-length aluminum tripod with bubble level and accessory shelf; 6 x 30mm achromatic viewfinder; eyepiece-holder (1.25"); #918A diagonal prism (1.25"); Series 4000 Super Plössl 26mm eyepiece (203SC) *or* Series 3000 Plössl 25mm eyepiece (102ACHR); provision for addition of optional #812 Polar Alignment Finder; operating instructions. **8" — $795** (+ $65 P & S); **4" — $595** (+ $55 P & S); **#535 R.A. Motor Drive System**...**$99; #812 Polar Alignment Finder**...**$49.**

LXD 500

For even broader capability, use the Meade® high-precision LXD 500 equatorial mounting, 20% larger and with dual-axis bronze worm gears — the finest equatorial mounting available in its price class.

SPECIFICATIONS: Models 203SC/500 and 102ACHR/500— Each telescope includes 8" f/10 Schmidt-Cassegrain *or* 4" f/9 Achromatic Refractor optical tube assembly with EMC super multi-coatings; LXD 500 equatorial mount with oversize bearings, high-precision bronze worm gears, micrometric manual slow-motion controls, and setting circles on both axes; manual control for azimuth alignment; elevation control and scale for polar alignment at latitudes from 15° to 60°; adjustable full-length aluminum tripod with bubble level and accessory shelf; 6 x 30mm achromatic viewfinder; eyepiece-holder (1.25"); #918A diagonal prism (1.25"); Series 4000 Super Plössl 26mm eyepiece (203SC) *or* Series 3000 Plössl 25mm eyepiece (102ACHR); provision for addition of optional #812 Polar Alignment Finder; operating instructions **8" — $895** (+ $65 P & S); **4" — $695** (+ $55 P & S); **#1701 R.A. Motor Drive System** with 4-speed controller...**$145; #1702 Dual-Axis Drive System** with 4-speed controller...**$195**; **#812 Polar Alignment Finder**...**$49.**

ADVANCED PRODUCTS DIVISION
Meade Instruments Corporation
The largest-selling telescopes in the world. ☐ *A Nasdaq company.*
6001 Oak Canyon, Irvine, California 92620 ☐ (949) 451-1450
FAX: (949) 451-1460 ☐ *www.meade.com*
© 1999

MEADE LX50

Advanced technology at the most affordable prices *ever.*

- **Battery-Powered, Completely Cordless Operation!** Meade LX50 models operate for more than 50 hours from six AA-size batteries inserted through the telescope's control panel.

- **Standard-Equipment Declination Motor and Hand Controller:** Plug the hand controller into the LX50 control panel and you're ready for dual-axis drive capability at any of 4 photo-guide or microslew speeds: 2x, 8x, 16x, or 32x, plus quartz-controlled sidereal-rate tracking in R.A.

- **Multi-Function Control Panel:** Includes connectors for CCD autoguiders; for the standard-equipment Declination motor; and for the optional Magellan II Computer-Corrector *(below)*.

- **Super Multi-Coated Optics:** The exact same EMC super multi-coated optical tube assemblies included with Meade LX200 models.

- **Massive LX200-type Fork Mounts:** Manufactured of the same aluminum castings as Meade LX200 models. Massive, rigid mounts that include the Meade LX worm-gear drive system with low periodic error for advanced photographic or CCD imaging applications.

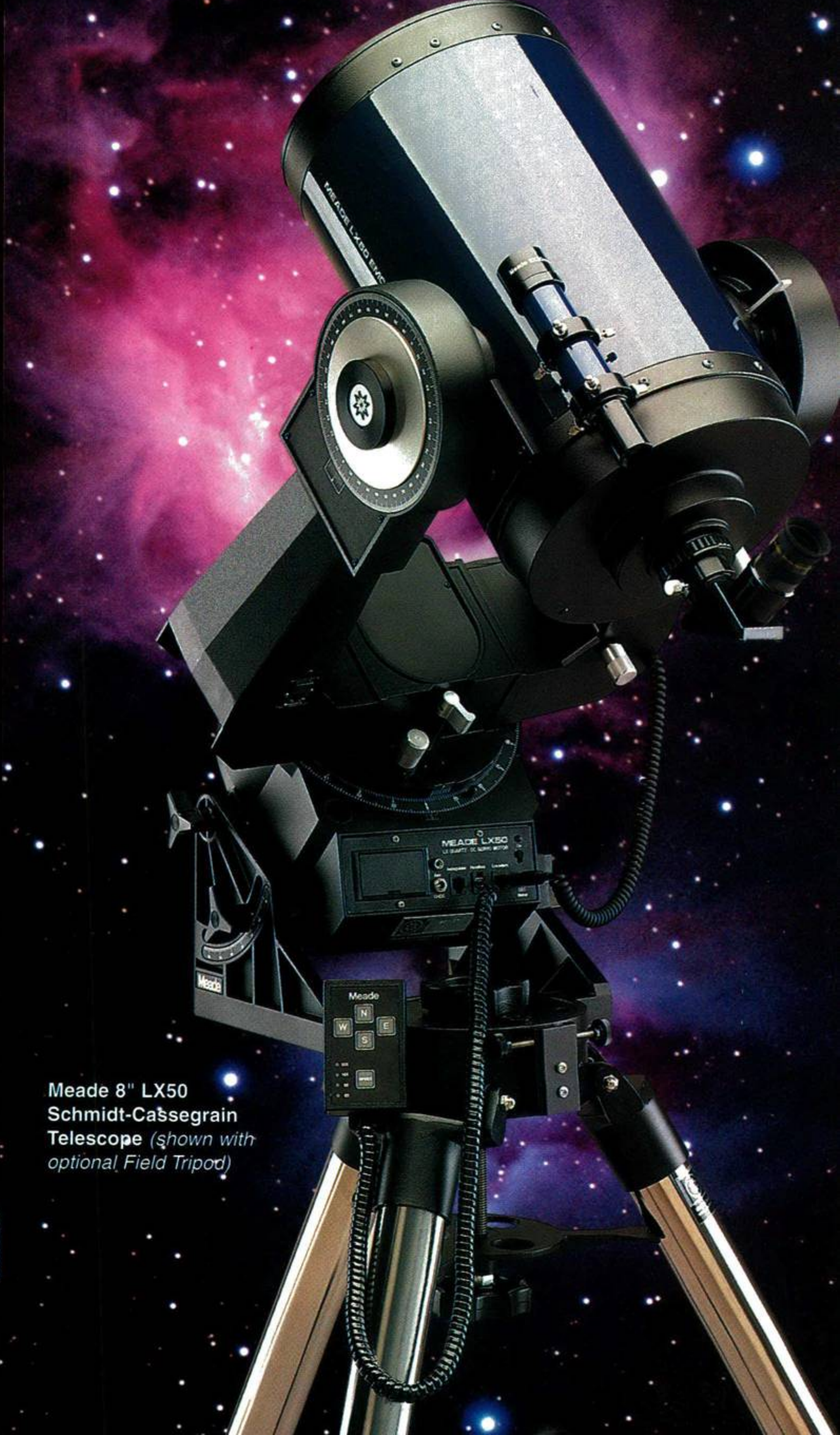
SPECIFICATIONS: 7", 8", and 10" LX50's — Each complete telescope includes 8" or 10" f/10 Schmidt-Cassegrain or 7" f/15 Maksutov-Cassegrain optical tube assembly with EMC super multi-coatings; heavy-duty LX200-type fork mount; 5.75" LX worm gear system in R.A.; multi-function control panel; DC servo Declination motor; manual and electric slow-motion controls on both axes; setting circles on both axes; keypad hand controller; 4-speed drive controls on both axes; battery compartment accepting six (user-supplied) AA-size batteries; 25 ft. power cord for telescope operation from 12v. auto cigarette lighter plug; 6 x 30mm (7" and 8" models) or 8 x 50mm (10") viewfinder; 1.25" diagonal prism; Series 4000 Super Plössl 26mm multi-coated eyepiece (1.25"); standard equatorial wedge with elevation scale, bubble level, and azimuth control; complete operating instructions.

8" LX50 Schmidt-Cassegrain	**$1395.**
10" LX50 Schmidt-Cassegrain	**1695.**
7" LX50 Maksutov-Cassegrain	**1795.**
Variable-Height Field Tripod	**295.**

Packing and shipping in the 48 states: 8"—$105; 10"—$145; 7"—$125; 7" Tube Assembly—$65.

Meade Magellan™ II Computer-Corrector for LX50 Telescopes: Plug the Magellan II into the control panel of your LX50 and enjoy an incredible range of advanced capabilities. ■ Fast manual slewing to any object, either from input RA and Dec or from the 12,218-object database. ■ High-resolution 4096-pulse encoders (5.3 arc-minute precision), concealed in special LX50 encoder compartments. ■ Large 32-character, red-backlighted display. ■ Quick 2-star alignment. ■ Four-speed (2x, 8x, 16x, 32x sidereal) dual-axis drive corrector/microslewing system.

#2024: Magellan II for LX50's—Includes Magellan II hand controller *(shown above)*; encoders for both axes; all required mounting hardware. Installs to any LX50 in minutes. **$495.** + $15 packing and shipping in the 48 states.



Meade 8" LX50 Schmidt-Cassegrain Telescope *(shown with optional Field Tripod)*

MEADE LX200

The largest-selling serious telescopes in the world.

In virtually every country in the world where serious telescopes are sold, more Meade LX200's are sold than all competing models *combined*. *Standard-equipment includes:*

- **Superb Optics:** LX200 diffraction-limited imaging capabilities are a legend in the industry; optical performance approaches that of a fine *ED* apochromatic lens.
- **Automatic GO TO Capability:** Meade LX200's are *the only commercial telescopes ever manufactured* that automatically GO TO any input R.A. and Dec., or to any of 64,359 objects in the onboard database, *to a precision of one arc-minute or better.*
- **LX200 High-Precision Pointing**™ is so precise it permits the positioning of *every* selected object on *every* commercially-available CCD chip *every* time, automatically — *a feat no other telescope priced under $40,000 can accomplish.*
- **Permanently-Programmable Smart Drive**™ routinely achieves 5 arc. sec. periodic error, an observatory standard.
- **9-Speed Dual-Axis Electronics:** Electronics that cover every possible contingency of telescope positioning—from 2x photo-guide, to 32x image centering, to 8°/sec. slewing across the sky, as well as 6 other dual-axis drive speeds in between.
- **Field Operation:** No other telescopes of such incredible capabilities transport so readily for field operation. The compact, optional #1812 Electronic DC Adapter allows for field powering directly from an automobile cigarette lighter plug.

SPECIFICATIONS: 7", 8", 10", and 12" LX200's — Each complete telescope includes 8" or 10" (f/6.3 or f/10) or 12" f/10 Schmidt-Cassegrain or 7" f/15 Maksutov-Cassegrain optical tube assembly with EMC super multi-coatings; heavy-duty fork mount with 4" polar ball bearing, dual-axis 5.75" worm gears, and multi-function control panel; manual and electric slow-motion controls on both axes; keypad hand controller with digital readout display, permanently programmable Smart Drive, 9-speed drive controls on both axes (7-speed on 12"), High-Precision Pointing, and GO TO controller; 64,359-object onboard celestial software library; 25 ft. power cord and adapter for telescope operation from 115v.AC; 8 x 50mm viewfinder; 1.25" diagonal prism (7", 8", 10") or 2" diagonal mirror with 1.25" adapter (12"); Series 4000 Super Plössl 26mm eyepiece; standard field tripod (7", 8", 10") or giant field tripod (12"); operating instructions.

8" LX200 Schmidt-Cassegrain	**$2795.**
10" LX200 Schmidt-Cassegrain	**3195.**
12" LX200 Schmidt-Cassegrain	**4495.**
7" LX200 Maksutov-Cassegrain	**3295.**

Packing and shipping in the 48 states: 8"—$105; 10"—$145; 12"—$215; 7"—$125.

Write, call, or fax Meade Instruments for your free copy of the 100-page Meade General Catalog.

Meade
MEADE LX200 EMC
MEADE LX200
Meade

Meade 10" LX200 Schmidt-Cassegrain Telescope

Prices shown are suggested U.S. national mail-order retail prices.

ADVANCED PRODUCTS DIVISION
Meade Instruments Corporation
World's Leading Manufacturer of Astronomical Telescopes for the Serious Amateur
6001 Oak Canyon, Irvine, California 92620 ■ (949) 451-1450
FAX: (949) 451-1460 ■ *www.meade.com*

© 1999

MEADE STARFINDER DOBSONIANS

Now with Series 4000 Super Plössl 26mm eyepiece as *standard equipment!* Consider these features:

Series 4000 SP26mm Eyepiece (1.25"): The premium SP26mm ocular permits all Meade Starfinder Dobsonians to perform absolutely to their maximum capabilities. This $80 eyepiece is now **standard-equipment** on all Meade Dobsonians.

Primary and Secondary Mirrors of Low-Expansion Pyrex® Glass: Unlike the plate glass optics of other Dobsonians that can become thermally unstable, all Meade Dobsonian optics are made of Grade-A fine-annealed Pyrex glass — the exact same professional-quality optics used on Meade Starfinder Equatorials.

Rigid, Durable, Beautiful Dobsonian Mountings, manufactured of cabinet-quality materials, provide extremely smooth motions of the telescope in both altitude and azimuth. Both telescope axes ride on zero-backlash Teflon/Nylon bearings, facilitating the quick location and easy tracking of celestial objects.

Full-Size 1.25" Rack-and-Pinion Focuser: For smooth, precise focusing of the image without wobble or backlash. Focus travel is 2.6"; accepts 1.25" eyepieces.

4-Vane Steel Secondary Mirror System: Permits locked-in support and precise centration and alignment of the secondary mirror.

5 x 24mm Viewfinder: Included with all Starfinder Dobsonian models for quick object-location in the main telescope. With crosshair eyepiece and 2-ring bracket.

Optical Tubes: The same strong, spiral-wound Sonotubes™ used on Starfinder Equatorials *(right),* tubes with excellent insulating characteristics that reduce internal thermal currents to an absolute minimum.

Performance! *Meade Starfinder Dobsonians and Equatorials are the largest-selling Newtonian reflectors of their apertures in the world.* Every Starfinder model opens up the skies to an extremely wide range of serious visual observing; all 110 Messier objects, thousands of NGC objects — nebulae, galaxies, star clusters, in all their variations of form, color, and extent, as well as the Moon and planets in stunning high-resolution detail. Starfinder Dobsonians are telescopes for visual observing; motor-driven Starfinder Equatorials may be used, in addition, for lunar and planetary photography, and even for limited deep-space photography.

Packing & UPS Shipping Charges to any address in the 48 states: 6"—$39; 8"—$49; 10"—$69; 12.5"—$79; 16"—$45 packing, shipped truck freight collect.

$270 Dobsonian Deluxe Accessory Package...only $49.95!

Outfit your Meade Dobsonian with all of the most popular accessories for advanced observing. At the time you order any Dobsonian model, specify the following Deluxe Accessory Package for your telescope, in place of the standard-equipment focuser, viewfinder, and eyepiece, ***for a total of only $49.95 additional:***

- 1 - **Meade #77 2" Giant Rack-and-Pinion Focuser,** with machined aluminum eyepiece-holders for both 2" and 1.25" eyepieces; includes drawtube lock and 2.6" focuser travel. *(reg. $59.95)*
- 1 - **Meade #637 6 x 30mm Achromatic Viewfinder,** with wide 7° field; 2-ring metal bracket. *(reg. $49.95)*
- 2 - **Meade Series 4000 Super Plössl 9.7mm and 26mm** multi-coated eyepieces — premium-grade eyepieces for high-resolution lunar, planetary, and deep-space observing. *(reg. $79.95 each)*

Purchased separately, the Deluxe Accessory Package sells for $269.80!

Meade Magellan I Telescope Computer System

Attach the optional Magellan I Telescope Computer System to your Starfinder Dobsonian and finding any of 12,218 celestial objects, or *any* object of known R.A. and Dec., is almost as easy as pointing the telescope! Magellan I's database includes the following objects:

7,840	NGC objects; the complete NGC catalog
4,093	IC objects from the Index Catalog
125	user-defined objects
110	Messier objects; the complete catalog
42	alignment stars for the Magellan system
8	major planets, from Mercury to Pluto
12,218	objects, total

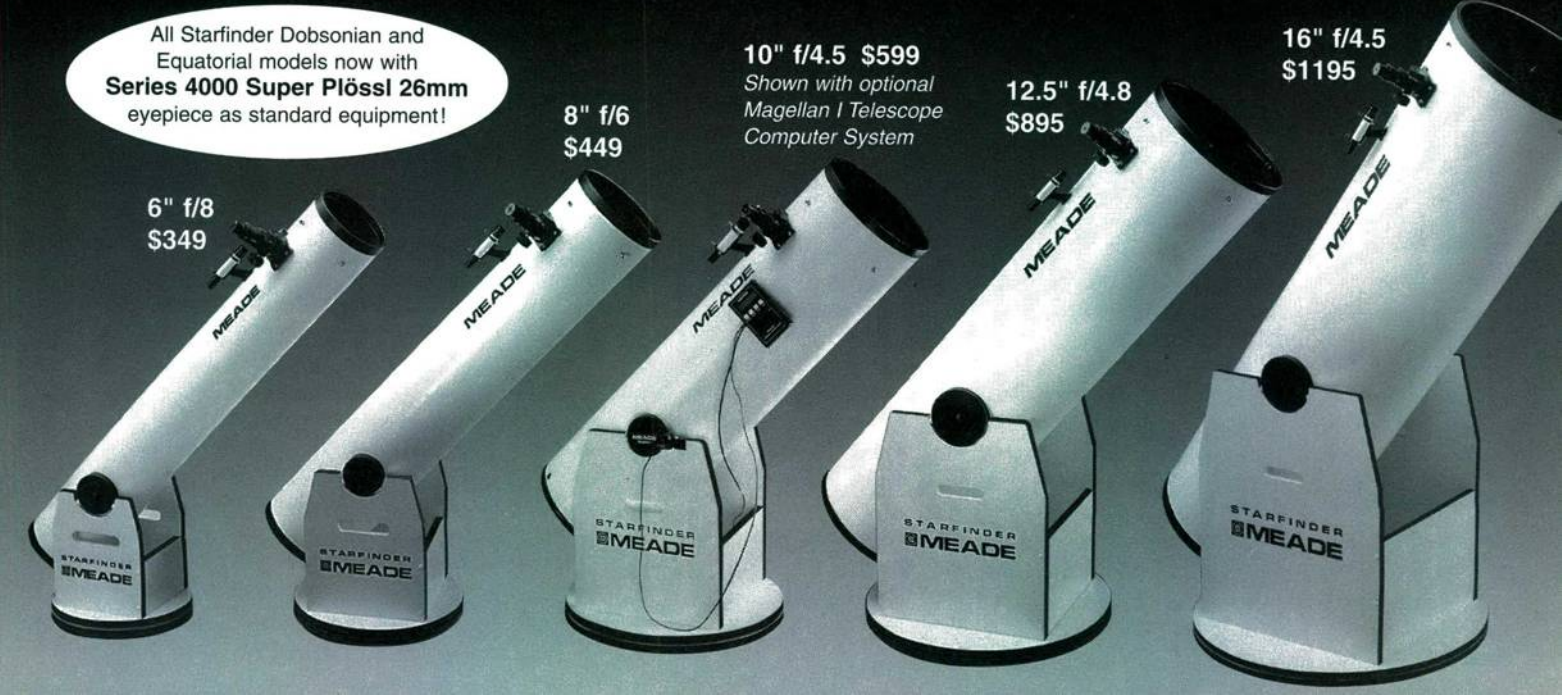
MEADE
ENTER
MODE
PREV
NEXT
ON
MAGELLAN I
TELESCOPE COMPUTER SYSTEM

Magellan I is supplied *complete* with control/display unit (4" x 5" x 1.25"); premium-grade, high-resolution encoders for each telescope axis (encoder precision is 5.3 arc minutes); RS-232 serial interface; bracket for placement of the controller on the telescope tube; and attachment hardware. Just add the user-supplied 9v. transistor radio battery, and Magellan I is ready to use. First-time installation is quick and simple.

#2010: for Meade Starfinder Dobsonian
6", 8", 10", 12.5", or 16" . . . . $295.
Packing & shipping in the 48 states—$15.

STARFINDER DOBSONIAN TELESCOPES ***Shown with standard-equipment 5 x 24mm viewfinder and 1.25" rack-and-pinion focuser.***

All Starfinder Dobsonian and Equatorial models now with **Series 4000 Super Plössl 26mm** eyepiece as standard equipment!



6" f/8
$349

8" f/6
$449

10" f/4.5 $599
Shown with optional Magellan I Telescope Computer System

12.5" f/4.8
$895

16" f/4.5
$1195

MEADE

STARFINDER EQUATORIALS

Special Eyepiece Offer! At the time you order any Meade Starfinder Equatorial telescope, you can buy a Meade Series 4000 Super Plössl 9.7mm eyepiece ***for only $29.95!*** *Purchased separately, the SP9.7mm eyepiece sells for $79.95.*

The fullest exposition of Meade astronomical telescopes, CCD imagers, and telescope accessories is contained in the 100-page Meade General Catalog.

Write, call, or fax Meade Instruments for your free copy!

With DC-powered drive systems for automatic tracking and Series 4000 Super Plössl 26mm eyepiece.

Professional-Grade Optical System: Hand-figured, parabolic primary mirror and elliptical flat secondary, both of Grade-A Pyrex glass. Optics are multi-coated and meet the theoretical limits of resolution.

Accessories and Components: Premium-grade multi-coated SP26mm eyepiece (1.25"); #637 6 x 30mm viewfinder with wide 7° field; strong, durable, spiral-wound optical tube with attractive white finish.

Precision Equatorial Mount: Manufactured of machined aluminum to tolerances of .001" or better, with 4"-dia. pier and die-cast tripod legs for rock-solid support of the optical tube. Moves effortlessly from object to object on precision bearing surfaces. Polar and Dec. shafts are 1" solid steel. Setting circles on both axes.

Battery-Powered Cordless Drive System! For fully automatic tracking of celestial objects. Operates over 50 hours from 6 (user-supplied) AA-batteries. Control panel also permits powering the telescope from 12v. auto cigarette lighter plug, using optional 25 ft. cord.

2" Giant Focuser: Meade #77 2" giant rack-and-pinion focuser is included as standard equipment, with eyepiece-holders for both 2" and 1.25" eyepieces.

Starfinder Equatorial 16: Includes equatorial mounting with 1.5" steel shafts, Sealmaster ball bearings, 6" dia. pier, and 6 x AA-size battery-powered worm gear drive; 8 x 50mm viewfinder; #77 2" giant focuser.

Packing & UPS Shipping Charges to any address in the 48 states: 6"—$65; 8"—$75; 10"—$90; 16"—$55 packing, shipped truck freight collect.

Meade Magellan Telescope Computer Systems

Magellan I: Use the Magellan I computer to manually slew the telescope quickly to any of 12,218 database objects, or to any object of known R.A. and Dec. Specifications and object database are identical to Magellan I for Starfinder Dobsonians *(see facing page).*

#2011: for Meade (DC-powered) Starfinder Equatorial 6", 8", or 10" . . . . $295.
#2012: for Meade (DC-powered) Starfinder Equatorial 16" . . . . 295.

Magellan II Computer-Corrector: Plug the Magellan II into the control panel of your Meade Starfinder Equatorial and you have all the capabilities of the Magellan I, above, including 12,218-object database, *plus* a 4-speed (2x, 8x, 16x, 32x), dual-axis, drive corrector/microslewing system.

#2018: for (DC-powered) Starfinder Equatorial 6", 8", 10" . . 495.
#2019: for (DC-powered) Starfinder Equatorial 16" . . . . 595.

Packing & shipping in the 48 states: Magellan I–$15, Magellan II–$20.

To Order: Contact your authorized Meade Advanced Products Mail-Order Dealer, below. Prices shown are suggested U.S.A. mail-order retail prices.

ASTRONOMICS, Norman, OK.
Orders: 800-422-7876; Info.: 405-364-0858.

FOCUS CAMERA, Brooklyn, NY.
Orders: 800-221-0828; Info.: 718-436-6262.

LUMICON, Livermore, CA.
Orders: 800-767-9576; Info.: 510-447-9570.

OCEANSIDE PHOTO & TELESCOPE, Oceanside, CA.
Orders & Information: 800-483-6287.

POCONO MOUNTAIN OPTICS, Moscow, PA.
Orders: 800-569-4323; Info.: 717-842-1500.

RIVERS CAMERA, Dover, NH.
Orders: 800-245-7963; Info.: 603-742-4888.

SHUTAN CAMERA & VIDEO, Chicago, IL.
Orders & Info.: 800-621-2248; IL: 312-332-2000.

Canada:

EFSTONSCIENCE, Toronto, Ontario.
Orders & Information: 416-787-4581.

KHAN SCOPE CENTRE, Toronto, Ontario.
Orders & Information: 416-783-4140.

ADVANCED PRODUCTS DIVISION

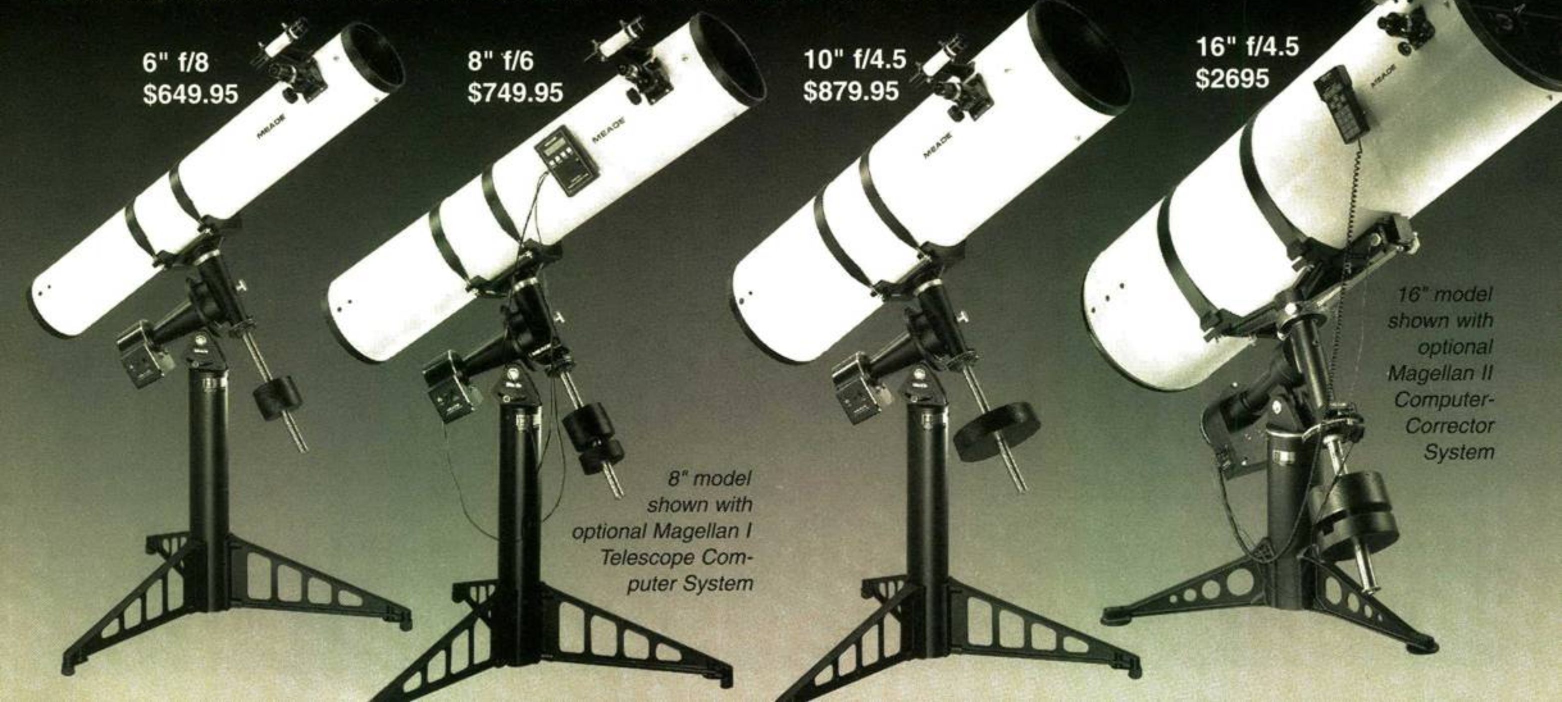
Meade Instruments Corporation

World's Leading Manufacturer of Astronomical Telescopes for the Serious Amateur

6001 Oak Canyon, Irvine, California 92620 ☐ (949) 451-1450
FAX: (949) 451-1460 ☐ *www.meade.com*

© 1998

STARFINDER EQUATORIAL TELESCOPES ***Shown with standard-equipment 6 x 30mm or 8 x 50mm viewfinder and 2" giant focuser.***



8" model shown with optional Magellan I Telescope Computer System

16" model shown with optional Magellan II Computer-Corrector System

MEADE RESEARCH-GRADE ACCESSORIES

Series 4000™ Super Plössls 52° field; multi-coated

Meade 4-element Super Plössls, updated and redesigned to utilize the latest in optical glass-types, are the finest general-purpose eyepieces available. For observing hairline lunar and planetary detail, splitting close doubles, or for deep-space; guaranteed to deliver more contrast and image sharpness than any other brand. Rubber eyeguards fold down for eyeglass wearers–a feature not available on competing brands. Multi-coated. All focal lengths through 32mm are parfocal.

Super Plössls (SP; 4-elements; 1.25"; 52°):

6.4, 9.7, 12.4, 15, 20, 26mm	each:	**$79.95** (4.54)
32mm (52°); **40mm** (44°)	each:	**99.95** (5.26)
56mm (52°; 2")		**199.95** (7.02)

Series 4000™ 2x Apochromatic Barlow Lens

#140: The most advanced Barlow lens available for commercial telescopes, the Meade #140 includes 3-element, multi-coated, air-spaced optics. Doubles the power of any eyepiece with which it is used and yields images absolutely unmatched in resolution, contrast and color correction. The #140 optically complements any telescope — refractor, reflector, or Schmidt-Cassegrain. Accepts 1.25" eyepieces. Mechanical components are of machined aluminum and brass. Lens diameter is 28mm; clear aperture 26mm.

$79.95 (5.26)

Series 4000™ Super Wide Angle 67° field; multi-coated

For exquisite wide-angle images at low-to-medium powers, with pinpoint edge-of-field resolution. Ideal for star fields, galaxies, and other deep-space phenomena. SWA 13.8mm, 18mm, and 24.5mm are superb complements to the #140 Barlow, above.

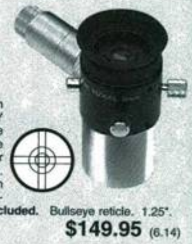
Super Wide Angle (SWA; 6-elements; 1.25"; 67°)–**13.8mm: $139.95** (4.54); **18mm: 149.95** (4.54); **24.5mm: 179.95** (5.26); **32mm** (2"): **239.95** (7.02); **40mm** (2"): **299.95** (7.02)

Series 4000™ Ultra Wide Angle 84° field; multi-coated

The ultimate eyepieces; extreme image sharpness over an amazing 84° field. A perfect optical match with Schmidt-Cassegrains and fast Newtonians.

Ultra Wide Angle (UWA; 8-elements; 1.25"; 84°)– **4.7mm: $169.95** (5.26); **6.7mm: 199.95** (5.26); **8.8mm** (1.25"/2"): **239.95** (7.02); **14mm** (1.25"/2"): **299.95** (7.02)

World's Most Advanced Illuminated Reticle Eyepiece



Series 4000 Plössl 9mm, with rubber eyecup and micrometric X-Y positioning of the reticle within the field. Greatly facilitates locking on the guide star. Sharp high-power imaging, excellent eye relief. Wireless red LED illuminator with adjustable brightness control. Multi-coated optics. **Internal batteries included.** Bullseye reticle. 1.25".

$149.95 (6.14)

Series 4000 Plössl 9mm—Same as above but with 6 ft. cord and plug for Meade LX3, LX5, LX6, LX100, LX200, and APO power panels, in place of wireless illuminator.

$129.95 (5.26)

Series 3000™ Plössls 50° field; multi-coated

Meade Series 3000 Plössls yield the finest image corrections obtainable from the classical 4-element Plössl design. Focal lengths from 5mm through 25mm are parfocal, so that, at most, only slight refocusing of the image is necessary from eyepiece to eyepiece. Unlike competing moderately-priced Plössls, Meade Series 3000's are **multi-coated** for maximum light transmission and image contrast. Chrome-plated brass barrels are threaded for standard filters. All eyepieces are fitted with fold-down rubber eyecups for comfortable observing. The PL40mm *(far right in photo)*, an excellent complement to any ocular set, produces spectacular low-power, wide fields, ideal for scanning the Milky Way. Manufactured exclusively to Meade optical designs, Series 3000 Plössls yield fine, high-resolution results on reflectors, refractors, and Schmidt-Cassegrains of any focal ratio.

Series 3000 Plössls (4-elements; 1.25"; 50°)

5, 6.7, 9.5, 16, 25mm each: **$49.95** (3.86); **40mm** (44° field): **$79.95** (3.86)

Series 4000 Photo-Visual Color Filters (1.25")–Premium filters, made of purest crown optical glass, dyed in the mass. For increased contrast and resolution on the Moon and planets. Thread into the barrels of virtually all 1.25" eyepieces sold today. Fully coated.

#8 Lt. Yellow; #11 Yellow Green; #12 Yellow; #21 Orange; #23A Lt. Red; #25A Red; #38A Dark Blue; #47 Violet; #56 Lt. Green; #58 Green; #80A Blue; #82A Lt. Blue

each **$14.95** (2.73)

Set #1–4 filters: #12, #23A, #58, #80A	**49.95** (4.54)
Set #2–4 filters: #11, #25A, #47, #82A	**49.95** (4.54)
Set #3–4 filters: #8, #21, #38A, #56	**49.95** (4.54)

Series 4000 Moon Filter (#ND96): Reduces glare and irradiation during lunar observing. 13% uniform light transmission across the visual spectrum. Threads into 1.25" barrels. **$16.95** (2.73)

Series 4000™ f/6.3 Focal Reducer/ Field Flattener

Manufactured to exclusive Meade optical designs; threads on to any Meade or Celestron Schmidt-Cassegrain rear cell and converts f/10 scopes to f/6.3 (or f/6.3 SCT's to f/4), while significantly flattening the field. Use with SCT visual or photo accessories. Actual visual field is increased by 56%, for fine wide-field views of star fields and nebulae. In astrophotography, reduces exposure times by about 50%, while producing an actual field diameter of 1.5" at the film plane. A tremendous aid with CCD imagers in reducing image size for locating and centering images on CCD chips. 4-element optics; multi-coated; 41mm clear aperture. **$129.95** (5.26)

#911B
#910B
#908B
#911N
#910N
#908N

Series 4000 Nebular Filters—Premium multi-layer interference filters, the finest obtainable. Use broadband ("B") filters to block most forms of light pollution; use narrowband ("N") filters in heavily light-polluted areas or for extremely high-contrast observing of faint nebulae.

#908B–Threads into 1.25" eyepieces, 26mm dia.	**79.95** (4.54)
#910B–Threads into 2" eyepieces, 44mm dia.	**119.95** (5.26)
#911B–Threads on to rear cell of Schmidt-Cassegrain telescopes. 36mm dia.	**99.95** (5.26)
#908N–Threads into 1.25" eyepieces, 26mm dia.	**89.95** (4.54)
#910N–Threads into 2" eyepieces, 44mm dia.	**129.95** (5.26)
#911N–Threads on to rear cell of Schmidt-Cassegrain telescopes. 36mm dia.	**119.95** (5.26)

#911X
#910X
#908X

Series 4000 Oxygen-III Filters Observe diffuse emission and planetary nebulae as you never thought possible! Exclusive Meade *60-layer* interference coating technology isolates the 496nm and 501nm O-III lines to tremendously enhance observable nebular structural detail in all telescopes.

#908X–Threads into 1.25" eyepieces, 26mm dia.	**99.95** (4.54)
#910X–Threads into 2" eyepieces, 44mm dia.	**159.95** (5.26)
#911X–Threads on to rear cell of Schmidt-Cassegrain telescopes. 36mm dia.	**149.95** (5.26)

2x Telenegative Barlow (1.25")

#122: Doubles eyepiece power with sharp, high-resolution, high-contrast imaging on telescopes of all types. 27mm dia. (26mm clear aperture). Excellent corrections for chromatic and spherical aberrations at all photo-visual wavelengths. Multi-coated. 1.25"

$47.95 (4.54)

#905 Variable Polarizer (1.25")

For glare reduction in observing the Moon. Includes two Polarizer filters mounted in a machined cell and permits continuously variable light transmission from 5% to 25%, to compensate for varying lunar surface brightness according to the Moon's phase and the aperture of the telescope. Accepts 1.25" eyepieces. **$49.95** (5.26)

2x Short-Focus Barlow (1.25")

#126: Only 2.5" long, the #126 works well with any telescope accepting 1.25" eyepieces, even those with limited focus range. Maintains the high image quality of the #122, above. Insert the #126 into star diagonal for 2x or insert star diagonal into #126 for 3x. 26mm clear aperture. Multi-coated.

$47.95 (4.54)

2x-3x Variable Barlow (1.25")

#127: Precision internal sliding lens assembly permits continuously variable power settings between 2x and 3x. Engraved scale indicates power in use. Yields bright, sharp, high-contrast images on telescopes of all types. Multi-coated; 1.25".

$59.95 (4.54)

2" Diagonal Mirror

#929: Permits use of wide-field 2" oculars. Threads on to rear cell of Meade and Celestron SCT's. Includes multi-coated precision optical flat made at the Meade factory; with 1.25" eyepiece adapter. **#930:** Same as #929 but with 2" barrel to fit into focusers with 2" eyepiece-holders.

#929 or **#930,** each: **$99.95** (6.85)

45° Erecting Prisms

Fully coated roof prisms to invert the astronomical image in Schmidt-Cassegrains or refractors during terrestrial observations, while presenting a convenient 45° observing angle. Specify **#927** (.965"), **#928** (1.25"), or **#931** (fits .965" focuser, accepts 1.25" eyepieces).

$42.95 (3.86)

Electric Focusers for SCT's

For extremely smooth microfocusing of the image. Does not affect use of the manual coarse-focus knob.

#1206 Electric Focuser: Plugs into control panel of Meade 8", 10", 12" LX200 models and operates from LX200 hand controller. **$149.95** (7.48)

#1205 Electric Focuser: For **all** other Meade 8", 10", 12" SCT models; includes separate hand controller; accepts one self-contained (user-supplied) 9v. battery.

$169.95 (7.88)

#777 Off-Axis Guider for SCT's

Internal prism diverts light for monitoring telescopic image during long-exposure astrophotography. Threads to any Meade or Celestron rear cell. Use with illuminated reticle eyepiece and T-Mount for your 35mm camera.

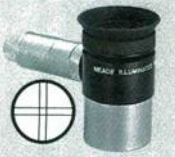
$79.95 (6.85)

Modified Achromatic Eyepieces

Meade 3-element MA eyepieces yield sharp, well-corrected images on the Moon, planets, and deep-space at a reasonable price. Multi-coated; threaded for filters; 1.25" barrel diameter. Apparent field: 40°. **MA 9, 12, 25, 40mm.**

each: **$37.95** (4.54)

MA12mm Illuminated Reticle Eyepiece



Excellent 3-element optical system, long eye relief, fully coated, with double crossline reticle; rubber eyecup. Wireless red LED illuminator and variable brightness control. 1.25". **Batteries included.**

$99.95 (3.45)

As above but with 6 ft. cord and plug for Meade telescopes with power panels, in place of wireless illuminator. **$79.95** (5.26)

Camera Adapters

Professional-quality adapters for rigid coupling of telescope-to-camera. Use for either Eyepiece-Projection or Prime Focus. Precision-machined of aluminum and brass, threaded for filters. Use with T-mount, available separately.

.965": $27.95; **1.25": $29.95** (3.86)

Variable-Projection Camera Adapter (1.25")

Machined sliding cell allows variable projection power in eyepiece-projection photography; permits precise selection of correct photo power in lunar and planetary photography; threaded for filters. Use with T-mount for your camera.

$39.95 (3.86)

Variable Tele-Extender

For eyepiece-projection photography with any Meade or Celestron SCT. Threads on to eyepiece-holder. Sliding cell with lock permits wide range of projection magnifications with the same eyepiece. Use with T-mount for your camera.

$39.95 (3.86)

T-Adapters for SCT's

Rigidly couples camera to telescope for prime focus photography with any Meade or Celestron Schmidt-Cassegrain. Use with T-Mount for your 35mm camera.

$26.95 (3.86)

CCD-Photo-Visual Flip-Mirror Systems

An essential accessory for imaging with ***any*** brand of CCD imager or for astrophotography with a 35mm camera. Flip mirror "down" to center the image while viewing with an eyepiece at 90°; flip mirror "up" to pass light on to CCD chip or 35mm camera film plane. Each unit includes: precision optical-flat Pyrex® mirror; 2-axis mirror-adjustment screws and locks for precise image centering; extra-fine helicoid focusing of the eyepiece; extension tubes for attaching either 35mm camera (using T-Mount) or CCD imager (using either T-threads or 1.25" barrel). Threads to rear cells of all Schmidt-Cassegrain telescopes; may remain on telescope and used in place of diagonal prism for visual observing as well.

"Over the past 10 years I have used all manner of flip-mirrors. The Meade Flip-Mirror Systems are absolutely the best—rock solid, high-precision, beautifully manufactured; they virtually eliminate all flexture between the CCD and telescope." — Jack Newton

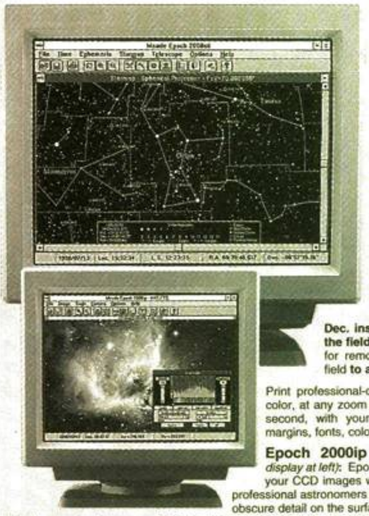
#644 Flip-Mirror System: Accepts any 1.25" eyepiece. Mirror clear aperture: 22mm. Use with CCD's up to Pictor 416XT or ST-7, or smaller; or visual observing with 1.25" eyepieces. **$149.95** (7.02)

#647 Flip-Mirror System: Accepts either 1.25" or 2" eyepieces. Mirror clear aperture: 40mm. Recommended for full-field 35mm astrophotography or with CCD's of any size, including all Meade Pictor Series through 1616XT, as well as ST-4 through ST-8; or for visual applications with 1.25" or 2" eyepieces. **249.95** (8.49)

#157 1.25" Adapter: Permits use of either Flip-Mirror on telescopes with 1.25" eyepiece-holders. (Requires approx. 2" additional focus travel with #644, 3" with #647.) **15.00** (3.86)

#644
MEADE
FLIP-MIRROR SYSTEM

#647
MEADE
FLIP-MIRROR SYSTEM



Epoch 2000® Sky Software

The most powerful astronomical software ever made available can now be yours for only $149!

Epoch 2000sk *(upper display at left)*: Now you can use the most advanced, most precise full-color sky software ever created, to zoom-in on telescopic fields **smaller than one arc second!** With star positions displayed as precisely as **0.01 arc second,** the Trapezium in Orion is no longer shown as a single point, as in other software, **but as four precisely oriented starpoints, just as they appear in the telescope.** No longer do you need to guess the R.A. and Dec. of an object located away from the field center, as in other programs: Epoch 2000sk dynamically reads out the R.A. and Dec. of the cursor position anywhere in the field **and updates R.A. and Dec. instantaneously as the cursor is moved about the field.** Meade LX200 owners can use Epoch 2000sk for remote auto-centering of objects in the telescopic field **to a precision of 30 arc seconds,** routinely!

Print professional-quality star charts in either black-and-white or color, at any zoom setting or sky scale between 180° and one arc second, with your own customized borders, headers, footers, margins, fonts, colors, and grids.

Epoch 2000ip Image Processing Software *(lower display at left)*: Epoch 2000ip makes it easy to enhance and analyze your CCD images with the same sophisticated techniques used by professional astronomers to uncover hidden structure in a spiral galaxy or obscure detail on the surface of a planet. This powerful software includes virtually every technique available for image enhancement. Techniques that bring out detail totally invisible in your original image, transforming it from the ordinary to the spectacular.

EPOCH 2000sk Sky Software: 281,000 objects supplied on 3.5" discs for Windows 3.1 or higher; fully compatible with Windows 95 .... **$149**

EPOCH 2000sk-CD Sky Software: 19 million objects, including the complete Hubble Guide Star Catalog; supplied on CD-ROM **179**

LX200 Interface Cable: for Meade LX200 operation by Epoch 2000sk **25**

EPOCH 2000ip Image Processing Software: Supplied on 3.5" discs for Windows 3.1 or higher; fully compatible with Windows 95 .... **$199**

f/3.3 CCD FOCAL REDUCER

Series 4000™ f/3.3 CCD Focal Reducer/Field Flattener

NEW!

Revolutionary 3-element Meade design permits ultrafast CCD imaging with **increased** edge-of-field resolution and color correction! Reduces CCD exposure times by up to 80%. Threads on to the rear cell of any Meade or Celestron Schmidt-Cassegrain. Converts f/10 Schmidt-Cassegrain telescopes to **f/3.3** and f/6.3 SCT's to **f/2.** Variable T-Adapter (included) allows range of f/ratios between f/3 and f/5 on f/10 SCT's and between f/1.9 and f/3.2 on f/6.3 SCT's. Use with CCD imagers of any brand and chip dimensions. Not for visual or photographic applications. Multi-coated; 41mm clear aperture. **$149.95** (5.26)

Plössl 25mm Illuminated Reticle CCD Framing Ocular

NEW!
MEADE
PLÖSSL
CCD FRAMING

Displays rectangular frames of all popular CCD chip sizes, including all Meade Pictor models and ST-4 through ST-8. Shows precisely the image size and orientation that appear on CCD chip. Insert directly into telescope eyepiece-holder, or use with Flip-Mirror *(above)*. Includes 4-element coated Plössl optics; lockable spacer ring to fix focus position; rubber eyecup; variable LED illumination control; batteries. 1.25". **$129.95** (4.54)

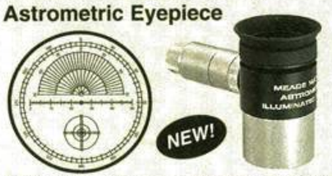
#825 8 x 25mm Right-Angle Viewfinder for ETX®

Permits comfortable right-angle viewing. Replaces standard-equipment ETX finder in seconds, using the same bracket. Wide-angle, achromatic, coated optics; actual field 7.5°. Precise helicoid focusing. **$49.95** (4.26)

#64 T-Adapter for ETX®

Threads to the photo port of any 90mm ETX model and rigidly couples any 35mm camera with removable lens to the telescope for lunar, planetary, or terrestrial photography. Includes extension tubes for either 1250mm (f/14) or 1450mm (f/16). Use with T-Mount for your 35mm camera. **$34.95** (3.86)

MA12mm Illuminated Reticle Astrometric Eyepiece



A high-precision eyepiece for a wide range of astronomical measurements. Includes four red-illuminated, laser-etched scales for measuring double star angular separations, position angles, planetary diameters, and lunar crater diameters, and for long-exposure photo-guiding. Modified Achromatic 3-element coated optics; diopter adjustment; rubber eyecup; variable LED illumination control; batteries. 1.25". **$119.95** (4.26)

ETX® Deluxe Field Tripod

Custom-designed by Meade specifically for ETX telescopes. Tripod height adjusts from 34" to 54", allowing for seated or standing observations through any ETX model. Micrometric controls in azimuth and elevation permit precise polar alignment of the ETX fork mount. Tripod head tilts and locks to 90° for terrestrial applications. Telescope attaches to tripod in seconds with 2 thumbscrews. All-aluminum construction. **$199.95** (10.00)

#774 Hard Carrying Case for ETX®

NEW!

For secure storage or travel with your ETX. Double-wall case plus die-cut foam lining accepts any 90mm ETX model, plus optional eyepieces, erecting prism, table tripod, hand controller, etc. Includes two steel latches with key. **$99.95** (8.58)

#932 45° Erecting Prism for ETX®

For terrestrial observing with any 90mm ETX model. Yields correctly oriented image and convenient 45° observing angle. Threads to ETX rear cell. Accepts any 1.25" eyepieces. Coated roof prism optics. **$49.95** (3.86)

Series 4000™ 8mm – 24mm Zoom Eyepiece

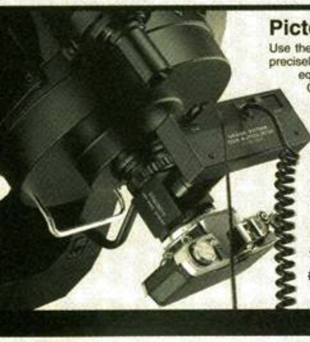
NEW!

MEADE 8mm - 24mm ZOOM

The finest zoom eyepiece available. High-resolution 7-element multi-coated optics, with 55° field at 8mm. Graduated scale in 1mm units indicates exact focal length in use. High-eyepoint yields comfortable observing even with eyeglasses. Internal zoom lenses move on the smoothest, most precisely-machined tracks yet developed for zoom optics. Performance is fully consistent with the finest fixed-focal length eyepieces. Threaded for filters; rubber eyecup; 1.25". **$219.95** (6.38)

ETX® Carry Bag

Soft-padded Cordura-type carry bag with shoulder strap; permits storage of any 90mm ETX model, plus table tripod legs, eyepieces, other accessories. **$36.95** (5.26)



Pictor™ 201XT CCD Autoguider

Use the Pictor 201XT to take even the longest exposures, knowing that the telescope will precisely track the object being photographed or imaged. Can be used on any telescope equipped with a dual-axis drive corrector. On Meade LX50 and LX200 Schmidt-Cassegrains and on other telescopes with an "Autoguider" connector the 201XT plugs into the telescope's control panel. On telescopes where the drive corrector is not integrated into the electronics of the telescope itself, the optional #520 Electronic Relay is required. The Pictor 201XT is completely self-contained; no separate control box or PC is required. Used with an off-axis guider or guide telescope, the 201XT automatically locks-on the brightest star in the field (a star that can be as faint as 12th-magnitude), sets its own integration time, and actuates all required dual-axis corrections for superbly guided astrophotographs or CCD images. Incorporates TC-255 CCD chip and operates from 12v. DC auto cigarette lighter plug with 25 ft. power cord, included. **$395.** (7.02)

#520 Electronic Relay: Use with Pictor 201XT on telescopes without autoguider connector or with retrofitted drive corrector. **95.** (5.28)

#541 AC Adapter: For 201XT operation from 115v.AC; includes 25 ft. cord. **35.** (6.56)

NEW!

#1244 Electric Focuser for ETX®

ELECTRIC FOCUSER
MEADE

Meade-engineered for smooth, rapid focusing with any 90mm ETX model. Four-speed operation from coarse to microfine. Standard-equipment hand controller accepts one 9v. (user-supplied) battery and focuses the standard ETX telescope. Or focus the ETX-90/EC model through the telescope's hand controller, with coil cord connecting to ETX-90/EC control panel. **$119.95** (6.85)

HOW TO ORDER

Prices shown are suggested U.S.A. mail-order retail prices and do not include any applicable sales taxes. Suggested shipping and handling charges to the 48 states by U.P.S. or U.S. Mail shown in ( ) next to each price. **The following national mail-order dealers carry all Meade accessories in-stock for immediate shipment:**

ASTRONOMICS, Norman, OK.
Orders: 800-422-7876; Info.: 405-364-0858.

FOCUS CAMERA, Brooklyn, NY.
Orders: 800-221-0828; Info.: 718-436-6262.

LUMICON, Livermore, CA.
Orders: 800-767-9576; Info.: 510-447-9570.

OCEANSIDE PHOTO & TELESCOPE, Oceanside, CA.
Orders & Information: 800-483-6287.

POCONO MOUNTAIN OPTICS, Moscow, PA.
Orders: 800-569-4323; Info.: 717-842-1500.

RIVERS CAMERA, Dover, NH.
Orders: 800-245-7963; Info.: 603-742-4888.

SHUTAN CAMERA & VIDEO, Chicago, IL.
Orders & Info.: 800-621-2248; IL: 312-332-2000.

Canada:

EFSTONSCIENCE, Toronto, Ontario.
Orders & Information: 416-787-4581.

KHAN SCOPE CENTRE, Toronto, Ontario.
Orders & Information: 416-783-4140.

© 1999

MEADE
MEADE 152ED/APO EMC
Meade LXD 750

Meade Model 152ED:
6" *ED* Apochromatic Refractor.
Shown with optional #1697 Computer Drive System.

Background image: **the North America Nebula —** A composite of two 45-minute exposures by Jason Ware on Fuji HG400 film with the Meade Model 152ED 6" *ED* Apochromatic Refractor.

ED APOCHROMATIC REFRACTORS

"The color correction and optics of my Meade 6" ED/APO are superb—the highest levels of definition, contrast, and resolution of any telescope near its aperture range that I have used in 44 years of observing. The Moon is awesome, incredibly detailed, with features taking on almost a 3-dimensional appearance. In good seeing the belts of Jupiter resolve into fine, delicate features; colors of the belts are faithful, dramatic, and easy to observe. Sketching the finer features of Jupiter's surface is a pleasure with this first-class instrument. When Saturn's rings are opened up, minor ring divisions are well-defined. The colors of Mars are beautiful and faithful, with good detail visible when the planet is favorably placed; many clouds are easily followed, and the polar caps are well-defined. Deep-space objects are viewed in high contrast. The telescope passes all test double stars easily. The LXD 750 equatorial mounting is excellent, extremely rigid and smooth; the computer drive puts objects in the center of the field. I can't praise the telescope enough. A magnificent instrument."
— Phillip W. Budine, Past Executive Director and Jupiter Recorder, Association of Lunar and Planetary Observers.

Fortunate indeed is the observer with a Meade *ED* Apochromatic Refractor at his or her disposal, for these are professional-class instruments capable of serious research. Use the massive Meade **LXD 650** (4", 5") or **LXD 750** (6", 7") equatorial mounts in conjunction with the optional **#1697 Computer Drive System** to slew the telescope across the sky and computer-point the instrument, automatically, *to a precision of one arc-minute,* or actuate any of 9 pushbutton-controlled drive speeds (from 2x photoguide to 8°/sec. fast-slew) on both axes. More than 40 Meade optional accessories are available to suit virtually any observing, photographic, or CCD imaging requirement.

Supplied complete per catalog specifications:

4" f/9 Model 102ED	**$2795.**
5" f/9 Model 127ED	**3295.**
6" f/9 Model 152ED	**4995.**
7" f/9 Model 178ED	**5995.**
#1697 Computer Drive System	**795.**

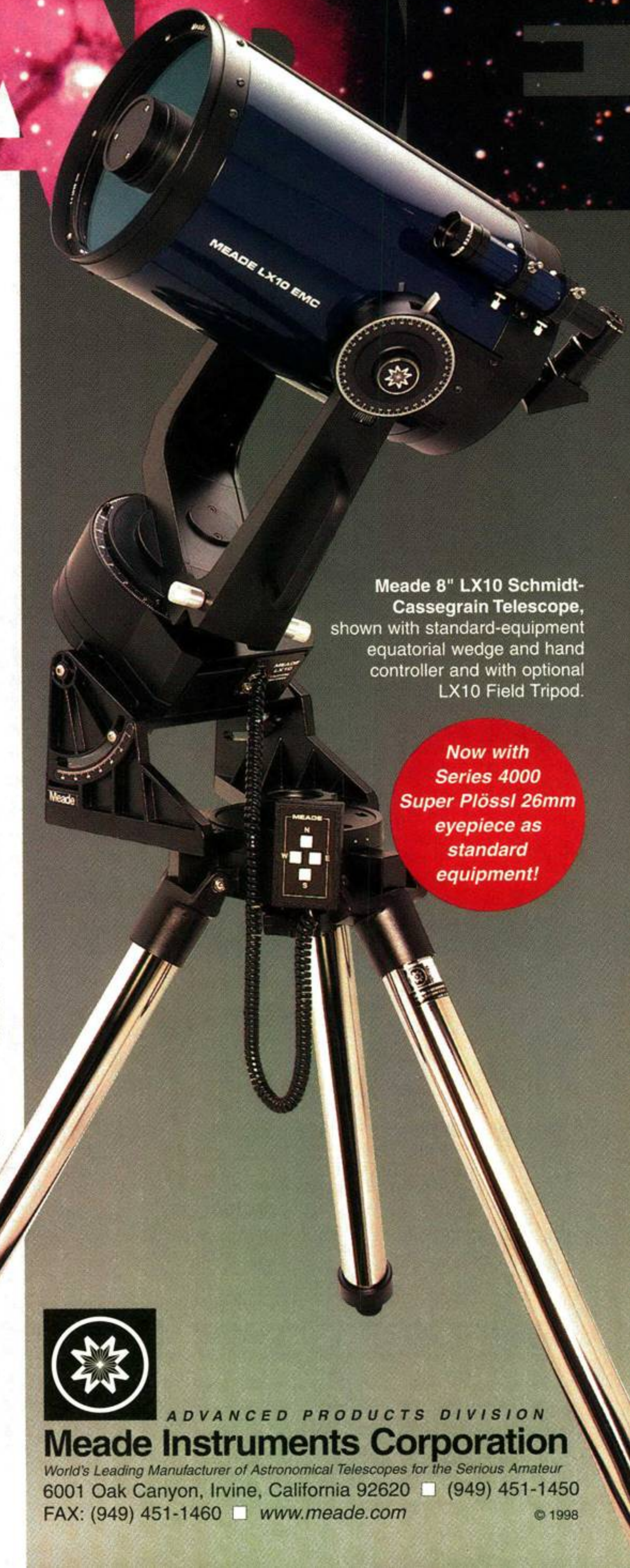
Packing and shipping in the 48 states: 4"—$105; 5"—$125; 6"—$185; 7"—$215. Prices shown are suggested U.S. National mail-order retail prices.

© 1999

8" LX10

8" LX10 DELUXE

The optical performance of a Meade 8" LX200 Schmidt-Cassegrain...for only *$995!*



Meade 8" LX10 Schmidt-Cassegrain Telescope, shown with standard-equipment equatorial wedge and hand controller and with optional LX10 Field Tripod.

Now with Series 4000 Super Plössl 26mm eyepiece as standard equipment!

8" LX10: For the serious amateur astronomer on a more limited budget, or for the more casual observer who nonetheless demands the very finest in optical performance, the Meade 8" LX10 satisfies every requirement. *Standard-equipment includes:*

Super-Multi-Coated Optical System: The *exact same* multi-coated 8" Schmidt-Cassegrain optical tube assembly as more expensive Meade 8" LX50 and LX200 models. **Series 4000 SP26mm eyepiece:** Complements the exquisite imaging of Meade 8" SC optics. **Equatorial Fork Mounting:** The relatively light weight, but very stable, LX10 fork mounting provides all of the rigidity required for sensitive high-power applications of the telescope, or for photographic or CCD imaging. **Cordless, DC-Powered Electronic Motor Drive:** With electronically-regulated DC servo motor for automatic *sidereal-rate* tracking; powered by four AA-size batteries that fit conveniently through the telescope's control panel; battery life is in excess of 50 hours. **Worm-Gear System:** The LX10's 5.75"-diameter worm gear produces extremely smooth, regular motion in R.A., with low periodic error — a periodic error that permits such advanced capabilities as long-exposure astrophotography or CCD imaging. **Hand Controller:** Essential for micro-guiding the telescope during long-exposure astrophotography, the LX10's pushbutton hand controller enables precise corrections in R.A. at 2x speed. With the optional electric Declination motor added to the telescope, the hand controller is functional at 2x speeds on both telescope axes.

SPECIFICATIONS: 8" Model LX10 — Includes 8" Schmidt-Cassegrain optical tube assembly with EMC super multi-coatings (D = 203mm; F = 2000mm, f/10); fork mount with setting circles, manual slow-motion controls, and locks on both axes; 5.75" LX worm gear reduction system; sidereal-rate electronically-regulated DC servo motor drive; 4-pushbutton hand controller for 2x speed corrections in R.A.; battery compartment accepting four (user-supplied) AA-size batteries (telescope may also be powered from an auto cigarette lighter plug, using optional 25 ft. cord); 6 x 30mm viewfinder; eyepiece-holder and diagonal prism (1.25"); SP26mm multi-coated eyepiece; standard equatorial wedge with elevation scale, fine elevation control, and 360° azimuth orientation capability; complete operating instructions. **$995.** (+ $65 packing & shipping in the 48 states)

8" LX10 Deluxe: At only $1149 the 8" LX10 Deluxe includes (a) the large-aperture Meade #544 8 x 50mm viewfinder (in place of the standard 6 x 30mm finder); (b) the LX10 Electric Declination Motor System, permitting dual-axis guiding corrections at 2x speed; and (c) Meade Epoch 2000 Jr. Sky Software with 10,000-object database — all at substantially lower cost than if the respective accessories were purchased separately.

SPECIFICATIONS: 8" Model LX10 Deluxe — Identical in all specifications to 8" Model LX10, above, but with Electric Declination Motor System provided as standard equipment, permitting dual-axis corrections at 2x speed; Meade #544 8 x 50mm achromatic viewfinder in place of 6 x 30mm viewfinder; and Meade Epoch 2000 Jr. Sky Software with 10,000-object database.

$1149. (+ $65 packing & shipping in the 48 states)

Field Tripod for LX10 or LX10 Deluxe . . . . **195.**
Electric Declination Motor System for LX10. . . . . **95.**
#2014 Magellan I Telescope Computer System for
LX10 or LX10 Deluxe,
with 12,218-object database . . . . **375.**

The 100-page Meade General Catalog is available free of charge from Meade Instruments or from authorized Meade dealers.
Prices shown are suggested U.S. mail-order prices.

ADVANCED PRODUCTS DIVISION
Meade Instruments Corporation
World's Leading Manufacturer of Astronomical Telescopes for the Serious Amateur
6001 Oak Canyon, Irvine, California 92620 ☐ (949) 451-1450
FAX: (949) 451-1460 ☐ *www.meade.com*

© 1998

THE LARGEST-SELLING TELESCOPES IN THE WORLD

Meade Instruments is pleased to recommend the authorized Meade dealers on these pages for your telescope-buying requirements. Whether you're looking for a quality entry-level telescope at under-$200, a fully equipped professional instrument at over-$5000, or one of more than 2 dozen models in between, there's a Meade telescope that's right for your budget and applications.

NATIONAL

Meade Telescopes and Accessories are available at
THE NATURE COMPANY
Over 100 stores nationwide.
Call **1-800-607-7888**

MULTIPLE STATES

DISCOVERY CHANNEL STORES
Orlando, Florida—Florida Mall
407-859-7001
Dallas, Texas—Dallas Galleria
214-701-8660
Atlanta, Georgia—Phipps Plaza
404-841-0081

ARIZONA

ASTRONOMY SHOPPE
Authorized Meade Dealer
Serving the Greater Phoenix Area
3232 E. Greenway Rd., Suite 1615,
Phoenix, AZ 85032
602-971-3170

ARIZONA

Quality Meade telescopes and accessories
Mr. Telescope
20 E. Camelback Rd.
Phoenix, AZ 85012
602-955-5521

CALIFORNIA

Studio City Camera
Full-line Meade. Optical expert on staff. Over 50 years' experience selling telescopes!
12174 Ventura Blvd., Studio City, CA 91604
818-762-4749

CALIFORNIA

WHAT IN THE WORLD
We will demo Meade products in our dark mountain skies!
28200 Hwy. 189, #E-210
Lake Arrowhead Village, CA 92352
909-337-5080

CALIFORNIA

Claremont Camera & Video
If it's quality Meade telescopes you're looking for – We offer it all!
863 W. Foothill Blvd., Claremont, CA 91711
909-626-2219

CALIFORNIA

Huge Meade inventory at low prices
Woodland Hills Camera
Telescopes • Binoculars
5348 Topanga Canyon Blvd., Woodland Hills, CA 91364
818-347-2270 or toll-free
Buy, Sell **1-888-4-ASTRONOMY** ***Trade***

CALIFORNIA

Largest Meade Display in California!
Boot's Camera
5587 North Blackstone Ave.,
Fresno, CA 93710
209-432-0446

COLORADO

Mike's Camera, Inc.
We carry one of the largest supplies of quality telescopes and accessories.
2500 Pearl St., Boulder, CO 80302
303-443-1715

CONNECTICUT

WHOLESALE OPTICS
WWW.ASTROPTX.COM
E-MAIL: astroptx@astroptx.com
Phone Orders 7 Days 9 am - 12 midnight • Sat. Hrs.: 11 am - 5 pm
Showrooms/Business Office:
57 North St., Suite 401, Danbury, CT 06810
Phone: **860-355-3132**

DELAWARE

CUTLER CAMERA
Binocular and Telescope Specialists
Stores in Wilmington, Newark and Dover
403 Branmar Plaza, Wilmington, DE 19810
302-475-8820

FLORIDA

Great National Camera Machine
Competitive Prices! Expert Service! Sales Nationwide! 30 Year Reputation.
1650 North Military Trail, Suite 104
West Palm Beach, FL 33409, 561-689-3166
Out of State 1-800-9-CAMERA

FLORIDA

PHIL'S CAMERA SERVICE
South Florida's Largest Selection of Quality Optical Instruments.
11517 S. Dixie Hwy., Miami, FL 33156
305-238-7842

FLORIDA

Jim's Photo Shack, Inc.
Authorized Meade dealer. We know telescopes—call for expert advice.
4100 E. Bay Dr., Clearwater, FL 34624
813-536-9661

FLORIDA

Complete line of fine Meade Products
Kenin Scientific & Optical Products
Big Display and We Do Mail Orders
1830 N.E. 163 St. • North Miami Beach
Phone: **305-940-7804** • Fax: **305-947-5943**

IOWA

THINKER TOYS, INC.
Quality Meade telescopes and accessories
4501 Southern Hills Drive, #17
Sioux City, IA 51106
712-274-0321

GEORGIA

Camera Bug Ltd.
Atlanta's Leading Telescope and Binocular Dealer. We Ship Practically Anywhere.
1799 Briarcliff Rd., Atlanta, GA 30306
404-873-4513 • Fax 873-3925

MASSACHUSETTS

F.C. Meichsner Co.
Decades of sales and service to New England's astronomers. Visit our accessible Boston showroom.
182 Lincoln St., Boston, MA 02111
1-800-321-VIEW

MASSACHUSETTS

Full-line dealer! We accept trade-ins! Meade telescopes on display for your inspection!
Harvard Camera
Town of Harvard: **978-456-8100**
Fitchburg: **978-345-2144**

MICHIGAN

RIDER'S HOBBY SHOPS
Serving Michigan Since 1972
Competitive Discount Prices
For the store location nearest you call **888-530-9780**. Locations throughout Michigan. HTTP://RIDERS.COM

MONTANA

NIGHT SKIES
Come and see the largest display of telescopes and accessories in Montana.
1550 Amsterdam Rd., Belgrade, MT 59714
Phone: **406-388-1205** e-mail: **nightsky**@wtp.net

NEBRASKA

ROCKBROOK CAMERA & VIDEO
Nebraska's Authorized Meade Dealer
2 Locations:
108th & W. Center Rd.
Omaha, NE 68144
402-397-1171

40th & O St.
Lincoln, NE 68510
402-488-4200

NEW JERSEY

N.J.'s Largest Display of Meade Telescopes.
Dover Photo Supply
25 E. Blackwell St.
Dover, NJ 07801
973-366-0994

NEW JERSEY

TUTHILL YOUR ASTRONOMICAL FRIEND
A full-line Meade dealer for 17 years!
11 Tanglewood Lane
Mountainside, NJ 07092
1-800-223-1063

NEW JERSEY

EDMUND SCIENTIFIC COMPANY
Call for a free catalog or see our full Meade line in our showroom.
101 East Gloucester Pike, Barrington, NJ 08007
1-800-728-6999

NEW MEXICO

PhotoSupply, Inc.
Stocking New Mexico's largest selection of Meade telescopes.
DeVargas Shopping Ctr., Santa Fe, NM 87501
505-982-2585

NEW YORK

Berger Bros. Camera & Video Exchange
Excellent Advice, Prices and Reputation For 50 Years
209 Broadway (Rte. 110), Amityville, LI, NY 11701
1-800-262-4160 • 516-264-4160

NEW YORK

We have specialized in sales and repair of telescopes for over 20 years! See us for expert advice!
Johnson Camera
6565 Kinne Rd. at Erie, Syracuse, NY 13214
315-446-0290

NORTH CAROLINA

Your quality Meade dealer in North Carolina
CC Sales/ Camera Corner
Phone: **800-868-2462**
Fax: **336-222-8011**
e-mail: **sky@camcor.com**
2273 S. Church St., Burlington, NC 27215

OHIO

Pete's PhotoWorld
Competitive Prices! ***Great Service!***
Telescope expert on staff ***Ask for Craig***
Telescope FAQ's www.photoworld.com
7731 Beechmont Ave, Cincinnati, OH 45255
petes@photoworld.com 1-800-736-7383

OHIO

McALISTER CAMERA & VIDEO
Full Line Meade. Reputable Dealer With Competitive Prices. Call Eric For Advice.
588 W. Schrock Road
Westerville, OH 43081 (Columbus)
Phone: 614-794-1865

PENNSYLVANIA

The Camera Shop In Bryn Mawr
Suburban Philadelphia's
Photo & Optical Specialists
572 Lancaster Ave., Bryn Mawr, PA 19010
610-527-0300

PENNSYLVANIA

CUTLER CAMERA
Binocular and Telescope Experts
7 Locations in PA and NJ
Largest Dealer in the Delaware Valley
314 Horsham Rd., Horsham, PA 19044
215-674-5727 • 1-800-220-5727

SOUTH CAROLINA

Wonder Works
Friendly, helpful service!
Open 7 days a week.
280 W. Coleman Blvd., Mt. Pleasant, SC 29464
803-849-6757

TEXAS

Analytical Scientific
If it's a quality Meade telescope you're looking for, call us.
11049 Bandera Rd., San Antonio, TX 78250
210-684-7373 • 800-701-STAR
http:\\Astronomy-Mall.com

TEXAS

Land, Sea & Sky Unlimited
Complete sales and service of Meade telescopes. We are optical specialists.
3110 S. Shepherd Dr., Houston, TX 77098
713-529-3551
www.neosoft.com/~lsstnr

WASHINGTON

Captain's Binoculars & Telescopes
Optical specialists, not just order-takers. Expert repairs in our own shop.
2500 15th Ave. West, Seattle, WA 98119
206-283-7242
www.captainsnautical.com

WASHINGTON

Meade Telescopes & Accessories
The Naturium
Northtown Mall, Spokane, WA
509-484-7014
Kitsap Mall, Silverdale, WA
360-698-3580

WASHINGTON

Anacortes Telescope & Wild Bird, Inc.
3202 Commercial Ave., Anacortes, WA 98221
360-588-9000 • Fax 360-588-9100
http://www.buytelescopes.com

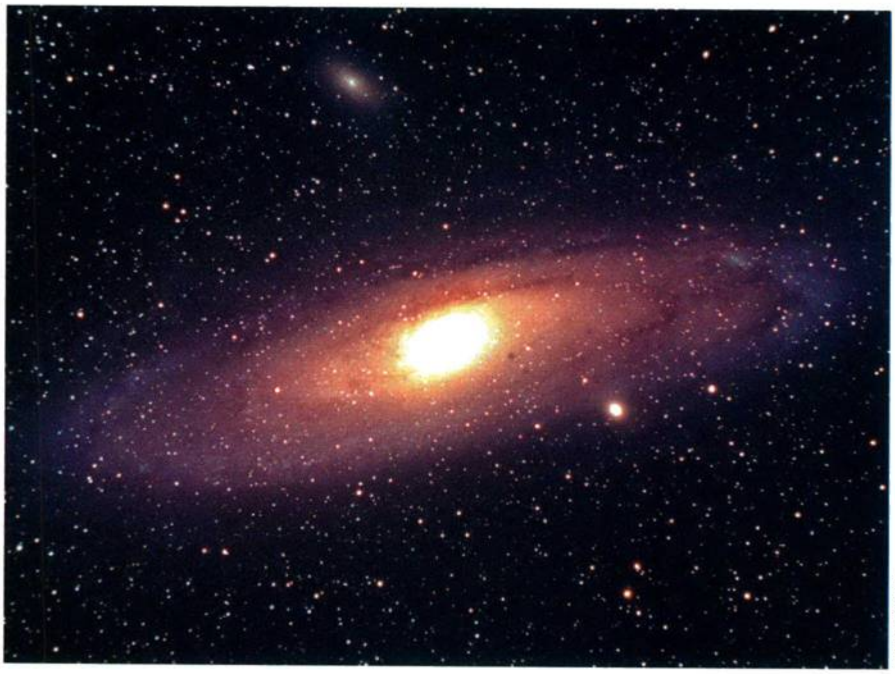
CANADA

PERCEPTOR
Friendly Service, Expert Advice, Low Prices, Full Meade Line, Delivery Across Canada
Brownsville Jct. Plaza, Box 38, Suite 201
Schomberg, Ontario L0G 1T0
905-939-2313 • Fax 905-939-8274

CANADA

LA MAISON DE L'ASTRONOMIE
Competitive Prices • Expert Service
7974 St. Hubert, Montreal, Quebec H2R 2P3
514-279-0063 • Fax **514-279-9628**
e-mail: rlotte@interlink.net
http://www.microid.com/maison.htm

How Far Away Is the Andromeda Galaxy?



Michael Stecker

The precise distance to Andromeda, the closest spiral galaxy to the Milky Way, is still uncertain.

I'm perplexed by the distance to M31, the Andromeda Galaxy, which *Astronomy* said in the November 1998 issue was 2.9 million light-years away, based on data from the Hipparcos satellite. Since the 1950s, astronomers have said the distance to Andromeda is about 2.2 million light-years. If the new figure is correct, it represents a 30 percent increase in the distance estimate. If true, are the distances to all the galaxies larger by 30 percent? — *Chris Morse, Sherborne, Dorset, United Kingdom*

All extragalactic distances are subject to uncertainty, and they are being revised as measurement techniques have improved. The distance to M31 is no exception. A technique to update the distance to M31 is based on measuring distances to Cepheid variable stars, which fluctuate in brightness as a result of regular variation in size and temperature. If one simply focuses on the distance to M31 as determined from its Cepheid stars, the most commonly adopted value over the past decade is 2.5 million light-years from Earth. The distance was derived from a technique called multicolor CCD photometry.

The Hipparcos parallaxes to galactic Cepheids found that they may be brighter — therefore farther — than once thought. Consequently, M31 might be roughly 2.9 million light-years away. However, that study has been challenged by more recent, detailed analyses that find no statistical evidence for a correction. In short, the distance debate has not been settled. Stay tuned. — Barry F. Madore, director, NASA Extragalactic Database, Pasadena, California

Kuiper Profile Praised

S. Alan Stern's profile of Gerard Kuiper, "Forging a New Solar System" (March 1999), was informative and well written. I learned a lot about the development of planetary astronomy, how recently it arose to prominence, and how much a single scientist had contributed to its development. Stern also inspired me with the story of an imaginative and tenacious scientist who also had been an important contributor to other fields of contemporary astronomy. — *Robert W. Muir, Salem, Oregon*

Mt. Graham Debate Continues

"High Priests of Astronomy" (December 1998) distressed us Apache people living on the San Carlos Reservation. The author quoted a Jesuit priest, astronomer Christopher Corbally, declaring that local tribes protested development of the Vatican Advanced Technology Telescope on Mt. Graham only after environmentalists' legal defeats. That is not true.

On December 14, 1989, our tribal council met with the Mt. Graham astronomers to announce its disfavor of the project and intent to pass a tribal council resolution in opposition to their desecration of the mountain. After our meeting, the environmentalists won court injunctions in 1990 and 1994 halting construction.

Even more upsetting to us was the priest's assertion that confusion existed among local tribal leaders over which peaks in the area they held sacred. Our tribal council, medicine men, and elders have issued countless proclamations and resolutions specifically opposing the construction of telescopes on Mt. Graham. We are weary of these attacks upon our religious beliefs. — *Delores Jordan, San Carlos Apache Reservation, Bylas, Arizona*

I am sorry to learn of the distress caused to Ms. Jordan since I realize that the whole matter of Mt. Graham as a sacred site has been a painful one. The interview situation is not always the best for conveying information accurately. If

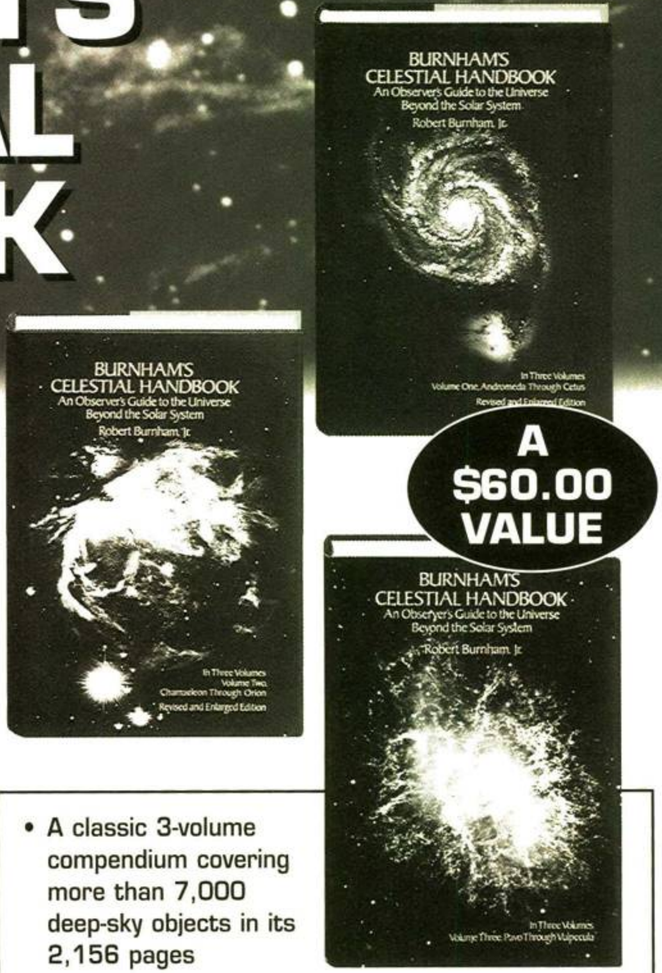
TAKE BURNHAM'S CELESTIAL HANBOOK

for $4.99

as your introduction to the

Astronomy Book Club

You simply agree to buy three more books—
at significant savings—within the next 12 months.



BURNHAM'S CELESTIAL HANDBOOK
An Observer's Guide to the Universe Beyond the Solar System
Robert Burnham, Jr.
In Three Volumes
Volume One, Andromeda Through Cetus
Revised and Enlarged Edition
Volume Two, Chamaeleon Through Orion
Volume Three, Pavo Through Vulpecula
A $60.00 VALUE

"The most significant event in the field of deep-sky publishing since the appearance more than a century ago of Webb's classic work, Celestial Objects for Common Telescopes*...If you call yourself an observer-whether beginner, seasoned, or just an 'armchair' enthusiast-you ought to have these volumes."* —Astronomy Magazine

The most complete sky manual of its kind, BURNHAM'S CELESTIAL HANDBOOK brings together a wealth of material in three easy-to-use volumes. Reflecting the interests and needs of today's amateur astronomer, it is the product of 25 years of tireless personal research by Robert Burnham, Jr., a former staff member of the Lowell Observatory and discoverer of the comet Burnham.

Completely revised and updated since it was privately printed in 1966, the handbook provides names, celestial coordinates, classification, and full physical descriptions for over 7,000 deep-sky objects that are accessible to observers with telescopes in the 2" to 12" range. This information—when used with a star atlas—enables you to find and locate almost every object of interest.

Burnham groups the objects according to the constellation in which they appear, and catalogs the stars by type. Information on each constellation is presented in four sections:

- Double and multiple stars
- Variable stars
- Star clusters, nebulae and galaxies
- Descriptive notes

And it's yours for $4.95. Order today!

Whether you're a professional or amateur enthusiast, the Astronomy Book Club offers you the finest astronomy materials available. You'll enjoy practical observing handbooks, atlases and how-to manuals, as well as general texts, in-depth investigations into topics on the frontiers of astronomy and astrophysics, and popular guides covering the lastest discoveries. All books are available to you at significant savings, with prices starting as low as $14.95.

- **A classic 3-volume compendium covering more than 7,000 deep-sky objects in its 2,156 pages**
- **Provides detailed descriptions of the most important stars, nebulae, and galaxies in each constellation from Andromeda through Vulpecula**
- **Contains 660 photographs plus numerous finder charts, graphs, and diagrams**

MEMBERSHIP MADE EASY

When your membership in the Astronomy Book Club is confirmed, you get the BURNHAM'S CELESTIAL HANDBOOK for $4.99, plus shipping and handling (plus sales tax where applicable). As a member, you can choose from quality publishers' editions and our members' editions of the best selections of astronomy titles. **You always save at least 20% off publisher's price** on every science book. With your first purchase of a regular selection, you earn **Bonus Credits you can use to save 50% off publishers' prices.** At 3-4 week intervals (15 times per year), you'll get the club magazine and a dated reply card. Three Special Selections will also be sent. If you want the Main Selection(s), do nothing; it will be sent automatically. If you prefer another selection, or no book at all, indicate your choice on the card and return it by the date specified. A shipping-and-handling charge (plus sales tax where applicable) is added to each shipment. You can order online at **www.booksonline.com/abc.** You always have 15 days to decide if you want the Main Selection(s). If you receive a book you do not want, because of late mail delivery of the magazine, return it free of charge. Your only commitment is to buy three books at the regular member's price in the next 12 months. You may cancel after that.

Visit us today at www.booksonline.com/abc

If reply card is missing, please write to Astronomy Book Club, Dept. L-EF9/90020, P.O. Box 6304, Indianapolis, IN 46206-6304, for membership information and an application. Offer valid in U.S.A. and Canada. Astronomy 5/99

REAL-TIME
EARTH OBSERVATION

Now you can receive wireless real-time images from Earth orbiting weather satellites on your PC. Images are relayed over shortwave radio and transmitted directly from the satellites. SSC makes hardware and software products that let you receive, decode, display and process these images.

If you need to see if it is worth trekking to a remote obeserving site, track storms, study global weather or just enjoy watching the world go by, SSC has a package for you.

Decoders start as low as $179.95. Complete satellite ground stations start at only $529.95. Call or write for a FREE catalog.

Software Systems Consulting
615 S. El Camino Real, San Clemente, CA 92672
Tel: (949) 498-5784 • Fax: (949) 498-0568
E-mail:support@ssccorp.com • http://www.ssccorp.com

OPT "YOUR ONE STOP Optics Shop"

Meade® Experts

Meade® CCD Cameras
"Quality, selection and priced to sell"

TALK TO FACTORY-TRAINED EXPERTS
We have the most knowledgeable, friendly, bend-over-backwards, knock-themselves out-for-you staff anywhere in the universe.
1-800-338-9638
Huge selection on display!

ETX Astro
"Hottest scope ever" -Sky & Telescope
In stock

LX200
World's best-selling serious telescopes
8" and 10" LX200's in stock

We're not just a phone number—we're a real store!

Experience our online catalog at www.optcorp.com

JMI • Kendrick • Losmandy
Lumicon • Optec • Orion
1000 Oaks • SBIG
Yadda Yadda Yadda

CELESTRON®
"Binoculars for every occasion"

Tele Vue
"TOPS IN THE FIELD"
Tele Vue specialists here to help you.

- Reflectors
- Refractors
- DOBS • SCTs

The NEW CM1100 11"
Available Now!

CELESTRON®

OCEANSIDE PHOTO & TELESCOPE
1024 MISSION AVE
OCEANSIDE CA 92054
OPEN 7 DAYS
email:opt@optcorp.com
1-800-338-9638

I said local tribes protested the development of the Vatican Advanced Technology Telescope only after environmentalists' legal defeat, then indeed that is not true.

What is true is that the opposition from the San Carlos reservation only became organized and obvious — in a letter received by the U.S. Forest Service, dated August 31, 1990 — when the issue of the endangered Mt. Graham red squirrel was becoming a less reliable way of preventing construction on the mountain. Another Sierra Club request for a temporary injunction was denied on August 28, 1990.

In the interview with writer Tony Ortega I did not mean to imply a confusion among local tribal leaders over which peaks in the area they held sacred. What I did find upon personal inquiry at the San Carlos reservation was that a variety of peaks was held sacred. For some, Mt. Graham was not a principal sacred peak.

This clarification is intended not to attack the religious beliefs of the Apache people, but to try to put what opposition there is into a factual context for better reflection and understanding. — Christopher Corbally, Vatican Observatory, Tucson, Arizona

Hubble Heritage Website

The January cover story, "Hubble Looks Back," introduced us to the goals of the Hubble Heritage Program and included a few of the fine images that have been made public. The program's website, http://heritage.stsci.edu/, includes all of the photos that have been released to date. — *Ronald D. Wong, San Francisco, California*

Correction

The phone number listed in the March issue for information on a three-dimensional Mars poster should be 818-708-8400.

Astronomy *invites you to talk back. Send letters to* Astronomy *Talking Back, P.O. Box 1612, Waukesha, WI 53187; e-mail to talking@astronomy.com. Letters may be edited for space and clarity. If you want to talk back to us, please visit our website, http://www.astronomy.com.*

Astronomy®

KALMBACH PUBLISHING CO.

CHAIRMAN OF THE BOARD
Walter J. Mundschau

PRESIDENT
Gerald B. Boettcher

VICE PRESIDENT, ADVERTISING
Scott Stollberg

VICE PRESIDENT, MARKETING
Michael Stephens

CORPORATE ART DIRECTOR
Maureen Schimmel

MANAGING ART DIRECTOR
Laura J. Miller

PRODUCTION MANAGER
Annette Wall

ADVERTISING SERVICES MANAGER
Sara Malin Everts

CIRCULATION MANAGER
Michelle Spehr

CIRCULATION SPECIALIST
Kirsten King

CIRCULATION COORDINATOR
Rochelle Ahrens

ADVERTISING DEPARTMENT
(800) 558-1544

ADVERTISING SALES MANAGER
Dan Koehler dkoehler@astronomy.com

ADVERTISING SALES REPRESENTATIVE
Michael Ellis mellis@astronomy.com

AD SERVICES REPRESENTATIVE
Tracy Blonien tblonien@kalmbach.com

NEWSSTAND DISTRIBUTION

U.S., CANADIAN AND INTERNATIONAL
H.D.G., The Hearst Corp., New York, NY 10019

SPECIAL E-MAIL ADDRESSES

Ask Astro askastro@astronomy.com
Hot Shots hotshots@astronomy.com
Star Stuff starstuff@astronomy.com
Talking Back talking@astronomy.com
Kids kids@astronomy.com
Customer Service customerservice@kalmbach.com
Ad Sales adsales@astronomy.com

• Telescopes • Binoculars • Biology • Consumer Optics • Photography Accessories •

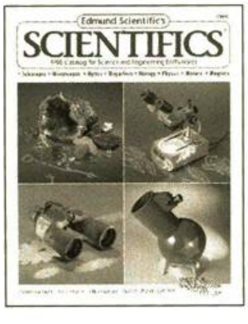
Educational Science Toys • Geology • Telescopes • Binoculars • Biology • Consumer Optics • Photography Accessories • Telescopes • Binoculars • Biology • Consumer Optics

Do you think of this as the Big Dipper?

Or, a conveniently placed marker for the M-51 galaxy?

The big picture comes into focus when you view it through the Astroscan® 2001. Its unique, cradle-in-your-arm design and ability to glide effortlessly in its table-top base make it ideal for beginners. Plus, its amazing 3° field and superb light gathering capability make those panoramic views all the more memorable. Call **800-728-6999 ext. 821** for a free catalog.

Astroscan® 2001, pg 3
$359.00



Edmund Scientific
If you love science.

SCIENTIFICS CATALOG DIVISION
Dept. A991C821, 101 E. Gloucester Pike
Barrington, New Jersey 08007-1380
E-mail us at: scientifics@edsci.com
Visit our web site at: www.edsci.com

EDMUND ONLINE

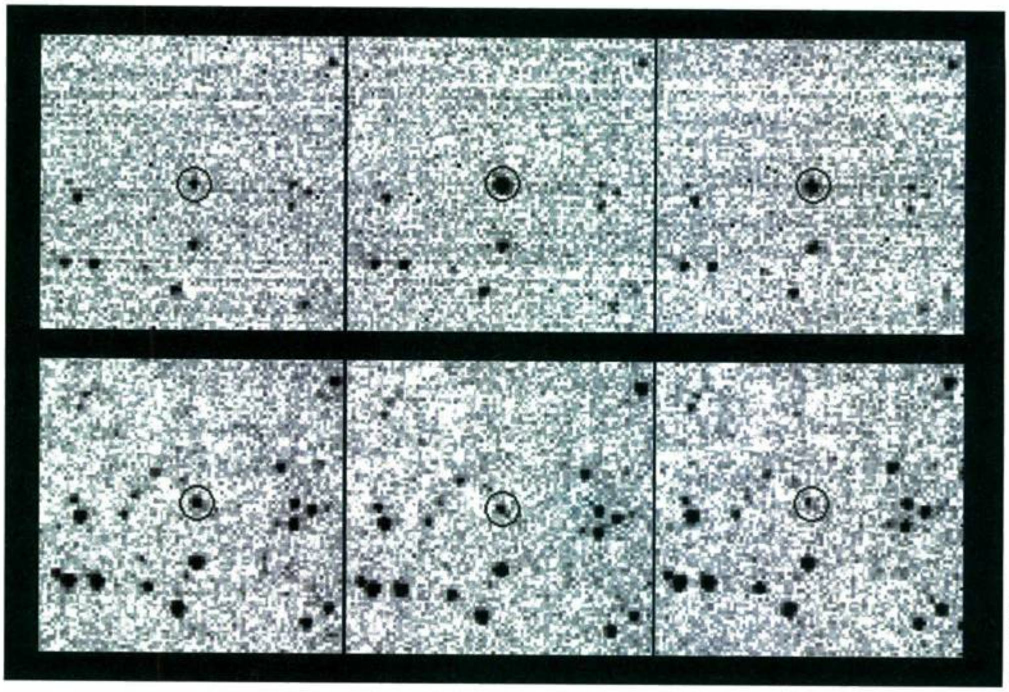
Educational Science Toys • Geology • Telescopes • Binoculars • Biology • Consumer Optics • Photography Accessories • Telescopes • Binoculars • Biology • Consumer Optics

• Telescopes • Binoculars • Biology • Consumer Optics • Photography Accessories •

ASTRONEWS

GAMMA RAY BURSTS

A Burst Like No Other



ROTSE Project

The circled splotches represent the brightening and fading of the brightest flash of visible light ever recorded — from a distant gamma-ray burst that radiated 100,000 times more visible light than a large galaxy.

▶ Astronomers aren't overly impressed by large numbers. After all, when you spend your life thinking about the size of the universe or the energy generated by a supernova, not much leaves you awestruck. But even astronomers were taken aback by an event on the evening of January 23.

On that day a powerful burst of gamma rays blasted through the solar system. Nothing unusual there — hundreds of these energetic bursts occur every year. But for the first time, astronomers on the ground nearly simultaneously observed the optical light from such a gamma-ray burst. And once they had estimated the burst's distance, they realized that, for a few seconds at least, the optical flash shone as brightly as 100,000 large galaxies.

The story began when NASA's Compton Gamma Ray Observatory detected the start of the bright gamma-ray burst. While the burst was still in progress, computers calculated a rough position and radioed it to the Goddard Space Flight Center in Greenbelt, Maryland. That position was then forwarded to astronomers located around the world.

Just 22 seconds after Compton's initial detection, the Robotic Optical Transient Search Experiment (ROTSE) in Los Alamos, New Mexico, snapped its first photo of the region in Bootes. They found a 12th-magnitude object that within five seconds brightened by a factor of 15, to a peak magnitude of 9.0 — bright enough to be seen in binoculars. Eight minutes later, the burst had faded by a factor of 100. "I was amazed," said ROTSE team leader Carl Akerlof of the University of Michigan. "At best, we expected something really dim, at the limit of our sensitivity. Instead we found a whopper."

The following night, a spectrum of the object's fading afterglow taken with the 10-meter Keck II Telescope on the summit of Mauna Kea in Hawaii found its redshift to be 1.61 — placing it some 9 billion light-years from Earth. Obviously, any object located that far away and glowing brightly enough to be seen in binoculars must be putting out an extraordinary amount of light. In fact, if this burst had occurred at a distance of roughly 600 light-years, it would have appeared as bright as the sun.

Astronomers have developed a number of models to explain gamma-ray bursts, including colliding neutron stars, neutron star-black hole mergers, or a type of exploding star called a hypernova. But even these may not be able to account for the January 23 megaevent. Caltech astronomer George Djorgovski speculates that this burst might have been gravitationally lensed by an intervening galaxy or cluster to appear much brighter than it actually was. Indeed, a faint and closer galaxy lies near the burst's position. But confirming that will likely take months of study.

— RICHARD TALCOTT

EXTRASOLAR PLANETS

Possible Earth-mass Planet Found

▶ It was just a tiny blip, lasting a mere 3 hours or so. But this slight excess brightening of a distant star may have been the first indication that low-mass planets like Earth are ubiquitous throughout the galaxy.

Two international teams of astronomers observed

www.telescope.com

Everything for the Amateur Astronomer

Come see what makes us click.

Secure Online Ordering | Same-Day Shipping | FREE Technical Support | 30-Day Return Policy

Telescopes | Binoculars | Eyepieces | Barlows | Light Pollution Filters | Finder Scopes
Equatorial Mounts | Mirrors | Software | Star Atlases | Accessory Cases | Flashlights
Diagonals | Dew Shields | Camera Adapters | Motor Drives

this excess brightening during a gravitational microlensing event. Microlensing occurs when a star passes between Earth and a more distant star. The intervening star's gravity acts like a lens, bending the light rays of the background star and making it appear brighter. If a planet orbits the lensing star and the alignment is just right, the planet will add a subtle and short-lived brightening as it passes through the background star's light path.

One of the teams, the MPS Collaboration (based in Australia), was following up an e-mail alert issued June 25, 1998, by the MACHO Collaboration, an international team that uses microlensing to search for dark matter. The MACHO team was asking other teams to follow up a microlensing event, which turned out to be the brightest event seen to date. As the microlensing event neared its peak, a second team, MOA (based in New Zealand), joined the hunt. Both MPS and MOA detected an additional brightening of the background star — above and beyond the original brightening — on July 4.

The amount of excess brightening during the 3-hour interval implies a planet with 0.00002 to 0.0001 of the parent star's mass, which is believed to be between 0.2 and 0.6 times that of the sun's. At the lower end, the planet's mass would be about that of Earth, and at the upper end, it would have the mass of Neptune (about 17 Earths).

Both teams, however, express caution. "The signal is not spectacular," says University of Notre Dame astronomer Sun Hong Rhie, a member of the MPS Collaboration. "We only claim that we see evidence. We would like to see spectacular signals."

Because the microlensing technique relies on chance alignments, there's no opportunity to conduct follow-up observations, so this report will likely remain shrouded in mystery. Still, gravitational microlensing is the only technique that can currently detect Earth-mass planets around normal stars. Over the next few years, it should give astronomers a better handle on the frequency and mass of extrasolar planets.

Using the more conventional method of looking for stellar wobbles, the European planet-hunting team led by Michel Mayor and Didier Queloz has discovered another "hot Jupiter." The planet has a minimum mass of 0.42 Jupiter (1.4 Saturns) and it orbits the solar-type star HD 75289 (94 light-years away) every 3.5 days at 0.046 the Earth-sun distance. This is the lowest-mass planet discovered by detecting stellar wobbles.

— Robert Naeye

MARS MISSIONS

ISAS Nozomi MIC Team/Motomaro Shirao

JAPANESE PROBE DELAYED. A stuck valve will prevent Japan's $995-million Nozomi ("Hope") spacecraft from reaching Mars on October 11, 1999, as scheduled. Because of the stuck valve, a critical engine burn on December 20, 1998, failed to boost Nozomi to sufficient velocity to reach its destination. But mission planners at Japan's Institute for Space and Astronomical Science determined that Nozomi could still reach Mars in December 2003 after two Earth flybys, and they express full confidence that the spacecraft will fulfill its science mission. Nozomi, which will study the interaction of the solar wind with Mars's upper atmosphere, is the first Mars mission attempted by a nation other than the United States and the Soviet Union/Russia. Nozomi snapped this image of the lunar far side during its December 18, 1998, flyby.

SETI

Message in a Bottle

▶ What if everybody in the galaxy is listening for radio signals, but nobody is sending? If that's the case, we might never know if anybody's out there.

As of April, we'll know of at least one transmitting civilization in the Milky Way Galaxy: us. In that month, an international team of scientists will begin transmitting a series of radio signals in the direction of four sunlike stars 50 to 70 light-years away. After passing those stars, the signals will continue outward into the galactic plane, where they could be detected by civilizations thousands of light-years distant.

This cosmic calling card is being sent by a 150-kilowatt transmitter coupled to a 70-meter radio telescope in the Ukraine. The project is funded by Celestis, Inc. of Houston, Texas.

While extraterrestrials on planets within a few dozen light-years could detect our military radar and the carrier waves of our radio and TV broadcasts, this is humanity's first intentional interstellar broadcast in 25 years. On November 16, 1974, radio astronomer Frank Drake used the 305-meter radio telescope at Arecibo, Puerto Rico, to send a message toward globular cluster M13.

Drake's signal was about 20 times more powerful. But the new message contains significantly more information, and it's being sent in directions where

Einstein deciphered the mysteries of the universe for every scientist in the world.

E=mc²

Isn't it about time someone deciphered them for you?

SALE PRICES + FREE SHIPPING!

At last…

The secrets of modern physics…taught in language you can understand …on video- and audiocassettes that let you learn at your own speed, wherever and whenever you wish!

NOW AVAILABLE FROM
THE TEACHING COMPANY:

Einstein's Relativity and the Quantum Revolution: Modern Physics for Non-Scientists

—taught to you by one of the most acclaimed science teachers in America!

Physics may well be the most important subject in the universe, a theoretical realm that ranges from the infinitesimally small to the infinitely vast, its laws governing time, space, and the very forces that created our world.

With scientists finally on the verge of unlocking the deepest secrets of the universe and with breaking news of discovery after discovery, an understanding of this fascinating subject has never been so important.

But if you're like most people, you've been frustrated in your efforts to understand these major science stories.

You're faced with ever-more-mysterious references to the "strong" force or the "weak" one, waves versus particles, "Big Bangs," "Big Crunches," and the 90 percent of the universe that may still be missing!

And until now, there was little you could do about it. It's hard for anyone, regardless of intellect, to grasp concepts like this based on nothing but a news reporter's hurried explanation.

That's why it's so exciting to offer one of The Teaching Company's best courses, *Einstein's Relativity and the Quantum Revolution: Modern Physics for Non-Scientists,* at a special low price that puts this brilliant course within reach of everyone who wants to understand physics.

Professor Richard Wolfson presents the theories of the great physicists so that *anyone* can understand them!

Newton and Copernicus. Time and space. Matter and motion. Einstein and the stunning revelations of relativity. Quantum physics. Quarks. Mesons. Even the future of the universe.

Best of all, these terms aren't explained to you with numbers or confusing references only a science major would know but with *exciting explanations in plain English.* Crystal-clear diagrams. And examples that bring each landmark concept out into the light *so you can understand it.* Even if you've never taken a physics course in your life!

And remember, this course is from The Teaching Company—the renowned education company that puts America's most gifted and exciting college teachers *on tape.* So you can enjoy this extraordinary learning experience where and when you want.

In your living room. Your car. The peaceful quiet of your yard. Or even while you jog!

On his own Middlebury College campus, Professor Richard Wolfson is a teaching legend, and to watch him share his love for his subject and his excitement over sharing it with *you,* is to be reminded of why you love learning in the first place.

Normally the 16 lectures of **Einstein's Relativity and the Quantum Revolution: Modern Physics for Non-Scientists** would sell for $199.95 in video and $129.95 in audio. But to introduce you to The Teaching Company, we are offering the complete course, for a limited time, for only $159.95 in video and $99.95 in audio.

The course is packaged with a complete outline including photos, diagrams, and a recommended reading list, and it carries The Teaching Company's unconditional guarantee of your satisfaction.

If the prospect of learning the never-more-pivotal subject of physics from a teacher of remarkable quality appeals to you, please respond today and get acquainted with The Teaching Company. We'll give you the kind of teachers you've always wanted and deserve.

The forces that shape our lives...explained with excitement and clarity!

PART I

Lecture 1: Space and Time, Matter and Motion
Lecture 2: The Clockwork Universe
Lecture 3: Let There Be Light
Lecture 4: Dichotomy in Physics
Lecture 5: Crisis in Physics: Einstein to the Rescue
Lecture 6: Stretching Space and Time
Lecture 7: Past, Present and Elsewhere
Lecture 8: Faster than Light? E=mc² and All That

PART II

Lecture 9: From the Tower of Pisa to General Relativity
Lecture 10: Black Holes and Curved Spacetime
Lecture 11: Into the Heart of Matter
Lecture 12: Quantum Quandaries
Lecture 13: Wave or Particle?
Lecture 14: Quantum Uncertainty: Goodbye to the Clockwork Universe
Lecture 15: The Particle Zoo
Lecture 16: Cosmic Evolution

LIFETIME SATISFACTION GUARANTEED!

Your Teacher

RICHARD WOLFSON, Ph.D., Professor of Physics and George Adams Ellis Professor of the Liberal Arts at Middlebury College, is one of the most renowned science teachers in the United States, easily moving among disciplines as varied as medical physics, experimental plasma physics, electronic circuit design, solar energy engineering, and theoretical astrophysics.

A legend among students for more than two decades at his own highly regarded campus, where his innovative and vibrantly interesting courses are perennially filled, he is equally at home before a non-technical audience. And his work outside the university arena, whether writing an article for *Scientific American* or creating a book-length explanation of *Nuclear Choices: A Citizen's Guide to Nuclear Technology,* has given Americans a new understanding of science and its impact on our lives in an age of extraordinary scientific discovery.

SAVE UP TO $50 ON THIS SPECIAL OFFER!

To order, mail coupon below or call our toll-free number: (Please refer to offer code 7713)
1-800-TEACH-12 (1-800-832-2412) Fax: 1-703-912-7756

The Teaching Company®
7405 Alban Station Court, Suite A107
Springfield, VA 22150-2318

Offer Code 7713

Please send me **Einstein's Relativity and the Quantum Revolution: Modern Physics for Non-Scientists**, which consists of sixteen 45-minute lectures on video- or audiocassette, with complete lecture outlines, diagrams, and handsome storage case.

(please check desired format) **FREE SHIPPING!**

SALE ☐ Audio*: Entire two-part course, $99.95 (reg. price $129.95), ~~plus $10 S&H.~~

SALE ☐ Video*: Entire two-part course, $159.95 (reg. price $199.95), ~~plus $10 S&H.~~

**Note: Virginia residents please add 4.5% sales tax.*

☐ Check or Money Order enclosed

☐ VISA ☐ MasterCard ☐ American Express Cards ☐ DISCOVER NOVUS

Account Number

Signature Exp. Date

Name (please print)

Mailing Address

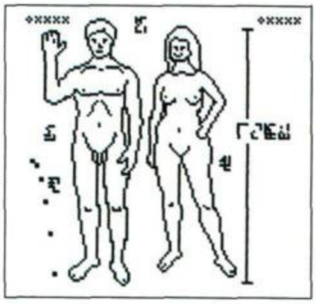
City/State/Zip

Phone *(If we have questions regarding your order)*

☐ **FREE CATALOG. Please send me a free copy of your current catalog (no purchase necessary).**

advanced civilizations are more likely to exist. Like Drake's message, it uses a binary code that establishes a mathematical language — probably the only language that we and any putative aliens have in common. If ET intercepts and decodes the message, he/she/it will learn about Earth, the solar system, human anatomy and biochemistry, and our civilization's level of technology. The final section invites a reply.

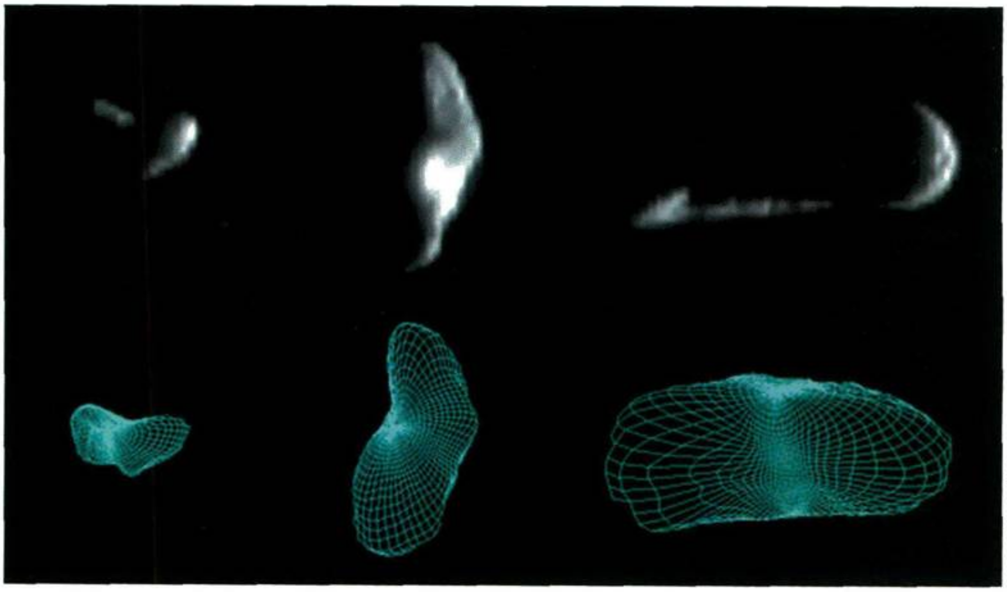
"There's an ethical problem raised by this project: Who has the right to speak for Earth?" asks astrophysicist Yvan Dutil of the Defence Research Establishment Valcartier in Quebec, Canada, who created the message with his colleague Stephane Dumas. But Dutil adds, "At some point, you have to do this. It's a way to ask for attention."



Yvan Dutil and Stephane Dumas (DREV)

Page 15 of the 23-page message tells ET about human beings.

If you're worried that these signals are inviting attack from hostile aliens bent on our destruction, it's already too late. As Dutil says, "In the next 50 years we'll have the technology to detect Earth-like planets around nearby stars. Any advanced civilization will have the same technology. They already know there is life on this planet, and they have probably picked up our radar."



Applied Physics Laboratory

These three images of Eros, taken over 2.5 hours by NEAR during its December 23, 1998, flyby, show the contorted shape of the asteroid.

NEAR

Eros Revealed

▶ The NEAR spacecraft's December 23 flyby of Eros (see "Better Late than Never," AstroNews, April 1999) has shown that the asteroid's longest dimension is 21 miles (34 km). Previous ground-based radio observations had suggested a long dimension of 25 miles. The flyby revealed that Eros's density is 2.7 grams per cubic centimeter, about the same as Earth's crust. This density is about twice that of NEAR's first asteroid target, Mathilde. NEAR also found two medium-sized craters, a 12-mile-long ridge, and evidence that the asteroid has a diverse surface composition.

"The ridge-like feature, combined with the measurement of high density, suggests that Eros is a homogeneous body rather than a collection of rubble such as Mathilde seems to be. It might even be a remnant of a larger body that was shattered by an impact," says imaging team leader Joseph Veverka of Cornell University.

NEAR will go into orbit around Eros in February 2000, where it will take images 200 times sharper than the flyby images. Still, the flyby served its purpose. "The flyby has given us fundamental information that will help us plan a better orbital mission at Eros," says NEAR project scientist Andrew Cheng of the Applied Physics Laboratory.

GALACTIC JETS

Faster than Light

▶ The Hubble Space Telescope's superior resolution has enabled astronomers to observe clouds of subatomic particles that appear to be moving up to six times faster than the speed of light. This is the first time such "superluminal motion" has been observed in visible light. The clouds are inside a 5,000-light-year-long jet that emanates from the core of the giant radio galaxy M87, 50 million light-years away in the constellation Virgo.

If you're thinking "That's impossible, nothing can travel faster than light!" you're right — at least according to Einstein's special theory of relativity. Superluminal motion is actually an optical illusion caused by the fact that the jet is pointing nearly straight at us, so the particles in the jet are almost able to keep up with the light they emit (see Ask Astro, March 1998). Still, the clouds are probably ripping through space at about 98 percent the speed of light (roughly 660 million miles an hour).

M87's jet is powered by a black hole weighing around 3 billion solar masses. Such monster black holes are responsible for violent activity and superluminal jets in many other galactic cores, which fall into categories such as radio

Swinburne
Swinburne
Swinburne

Astronomy Online

Online Graduate Certificate Course in Astronomy

Swinburne Astronomy Online includes

- **general-interest astronomy units open to all,**
- **plus more specialist units to gain a Graduate Certificate in Astronomy**

Combining an exciting mix of astronomical simulations, web-sites, newsgroup discussions & guest contributors on the latest astronomy headlines, Swinburne Astronomy Online is now available worldwide.

Applications are now being accepted. For more information, visit our web site: www.swin.edu.au/astronomy
or contact

Swinburne

Dr. Margaret Mazzolini,
mmazzolini@swin.edu.au
Astrophysics & Supercomputing,
BSEE, Mail Box 31
Swinburne University of Technology
P.O. Box 218, Hawthorn
VIC 3122 Australia
FAX:+61 3 9819 0856

F. C. Meichsner Co., Inc.

Our 81 years of experience and knowledge will help you get the best optics for your money!

☆ Celestron ☆ Miyauchi ☆ Used Equipment
☆ Meade ☆ Fujinon ☆ Repair Service
☆ Tele Vue ☆ Nikon ☆ Large Showroom
☆ Takahashi ☆ Swift ☆ Worldwide Shipping
☆ Questar ☆ Bushnell ☆ Free Price List

☆ Accessories Always in Stock • Call for Monthy Specials

Call us at: (800) 321-VIEW! (8439)
Fax: 617-426-0837 (24 hours)
E-Mail: Meichs@aol.com
Visit us at: 182 Lincoln Street, Boston, MA 02111
Web site: http://www.meichsner.com

LENSPEN™

SUPERIOR LENS CLEANING SYSTEMS FOR ALL FINE OPTICS

SAFE TO USE ON ALL LENSES

CLEANING COMPOUND WILL NOT SPILL OR DRY OUT

FLEXIBLE CLEANING TIP

REDUCES STATIC BUILD-UP

HANDY DUST REMOVAL BRUSH

Actual Tip Sizes

LENSPEN miniPRO

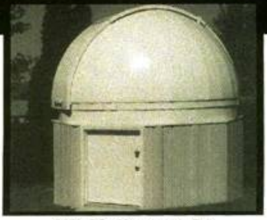
TRY miniPRO TOO!

It's specially designed for smaller optical lenses

For more information visit our website:
http://www.lenspen.com
or contact us at: (604) 681-6472

LensPen is a registered trademark of PARKSIDE OPTICAL INC. Vancouver BC Canada

HOME-DOME®
&
PRO-DOME™



HD-10 Hanover, PA

- True Rotating Dome
- 6, 10, 15ft. Diameter
- Wide Slot Openings
- Easy Assembly
- All Fiberglass
- Complete Systems Priced from $1950

Also, dome automation systems for remote observing. Call for more information

Technical Innovations, Inc.
22500 Old Hundred Rd.
Barnesville, MD 20838
Ph: 301-972-8040
Fax: 301-349-2441
www.homedome.com

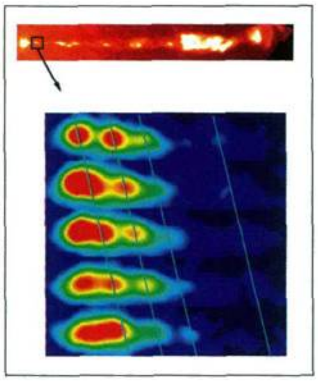
FREE Brochure

TUTHILL,
YOUR ASTRONOMICAL FRIEND SAYS

Start now to watch and photograph Sun Spots as they grow toward the next Solar Maximum with our SOLAR SKREEN® Sun Filter on your finder, binoculars or telescope.

SOLAR SKREEN® FILTERS give sharper images of even the smallest Sun Spots than window glass solar filters. Send a large (9x12") SASE envelope (4 stamps) for a FREE sample of SOLAR SKREEN®.

Call 800-223-1063 for details of the
SOLAR SKREEN® CHALLENGE
Roger W. Tuthill, 11 Tanglewood Ln., BX
Mountainside, NJ 07092
www.tuthillscopes.com



John Biretta (STScI), et al., and NASA

Hubble captures blobs of particles in M87's jet that appear to be moving faster than light.

galaxies, quasars, and blazars (see "Black Hole Hunters," page 48). "Our discovery of fast superluminal speeds in M87 essentially confirms that all of these objects are basically the same beast, powered by supermassive black holes, and differ only in orientation with respect to the observer," says John Biretta of the Space Telescope Science Institute, leader of the Hubble imaging team.

PROTOPLANETARY DISKS

The Disks of Taurus

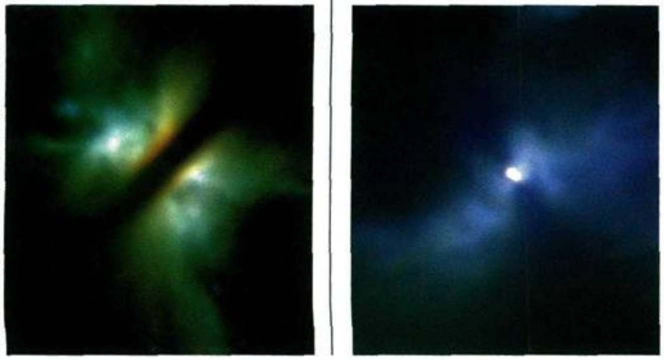
▶ Theorists had predicted decades ago that newborn stars would be surrounded by swirling disks of dust and gas. In 1992, the Hubble Space Telescope imaged disks around a few infant stars in the Orion Nebula, providing dramatic confirmation of the prediction.

Now, two teams of astronomers have used Hubble to take spectacular pictures of another dozen young stars in the Taurus star-forming cloud. Because the Taurus cloud is only 450 light-years away, three times closer than Orion, these new images are among the most detailed to date of the immediate surroundings of stars at the tender age of about a million years (see "Spying on Planetary Nurseries," November 1998).

The new images reveal gigantic dark lanes silhouetted against bright nebulous emission. "We think the dust lanes actually represent massive protoplanetary disks seen edge-on and often hiding the central star," explains Caltech's Deborah Padgett, who led the team that imaged Taurus disks with Hubble's NICMOS near-infrared camera. Outflowing gas has presumably cleared regions in the stars' dusty surroundings, creating the wing-like patterns seen in some of the images.

According to Padgett, one of the objects, the so-called Butterfly Star, is "a whopping structure" some 15 times the size of the solar system and containing a few thousand Earth masses of material. Images from Hubble's WFPC2 optical camera, taken by a team led by Karl Stapelfeldt of the Jet Propulsion Laboratory (Stapelfeldt and Padgett are husband and wife), show jets of material shooting perpendicular to the disks. Two of the objects with disks have turned out to be close binary pairs, suggesting that gravitational interaction of binaries does not always disrupt disks. Stapelfeldt sees it as "further evidence that planet formation should be possible even in binary star systems."

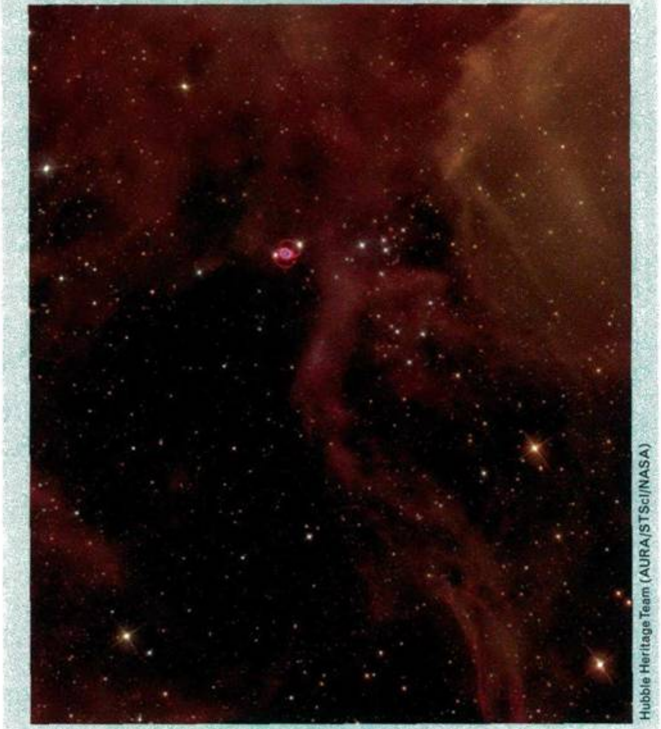
Space Telescope Science Institute director Steven Beckwith, who has worked on circumstellar disks for more than a decade, adds: "You can see that the images match very well with our ideas about star formation and the origin of planetary systems." — RAY JAYAWARDHANA



Deborah Padgett (IPAC/Caltech), et al., and NASA

These near-infrared images from Hubble's NICMOS camera show dusty disks surrounding two newborn stars in the Taurus star-forming cloud; the Butterfly Star is on the left.

HUBBLE HERITAGE PROGRAM



Hubble Heritage Team (AURA/STScI/NASA)

A DEEP VIEW OF A SUPERNOVA REMNANT. The latest Hubble Heritage Program release shows glittering stars and wisps of gas surrounding the two outer rings of the remnant formed by Supernova 1987A. The composite image was created from exposures made with the Hubble Space Telescope's Wide Field and Planetary Camera 2 in September 1994, February 1996, and July 1997. Several years from now the supernova's winds will sweep into the ring and reenergize it, creating celestial fireworks.

IDENTI-VIEW™

PREMIUM GLASS SOLAR FILTERS

- SAFE • HIGH QUALITY
- STRICT CONTROL STANDARDS
- LIMITED LIFETIME WARRANTY

CLASS "A"

Color band - blue. Class "A" filters are made with the same premium quality polished glass and multi-alloy coating as Class "B". An additional steel alloy added to the coating process makes our Class "A" filters extremely scratch and fade resistant. Excellent for visual and photographic use. Light transmission is 1/1000th of 1%.

CLASS "B"

Color band - white. Class "B" filters are made with polished glass and multi-alloy coating. These filters offer great durability and will provide many years of service and enjoyment with normal use. Can be used visually and for photography. Light transmission is 1/1000th of 1%

CLASS "C"

Color band - red. Class "C: filters are specifically coated to a lighter density (ND-4). They are for photographic use only. This filter is intended for use by professionals and serious hobbyists. Light transmission is 1/100th of 1%.

ORDERING INFORMATION

1. State scope brand and model number, aperture and outside diameter with filter class and price.
2. Make check or money order payable to J.M.B. Inc. All foreign checks must be payable through a U.S. bank.
3. Shipped free within th continental United States. All others add $5.50 Shipping and Handling per filter. Michigan resident add 6% sales tax, allow 2-3 weeks for delivery.

Now taking orders for the
August 1999 Eclipse.

VISA **J.M.B. INC.** MasterCard

20762 Richard • Trenton, MI 48183
(734) 675-3490 • FAX (734) 692-5772
"Imitated but never duplicated"

WARNING: May cause heart palpitations, nausea and shortness of breath. Enjoy.

Starry Night

Fasten your seatbelt and prepare for lift-off with the most realistic astronomy program in its class. View the universe from anywhere in the solar system. Explore millions of celestial objects across 14,700 years. Even control your telescope. Download a free trial version at www.siennasoft.com or call 1-877-782-7788 toll free.

Win/Mac

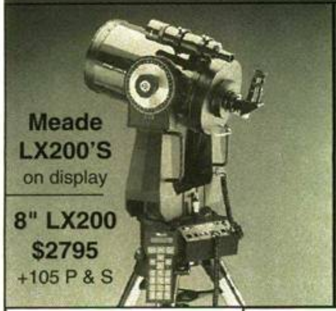
Starry Night DELUXE™

www.siennasoft.com | **The Realistic Astronomy Software**

Rivers CAMERA SHOP

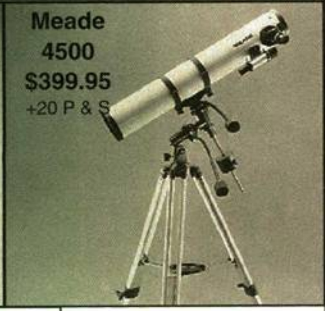
"Call for our informative catalog"

AUTHORIZED MEADE® APD MAIL-ORDER DEALER



Meade LX200'S
on display

8" LX200
$2795
+105 P & S



Meade 4500
$399.95
+20 P & S

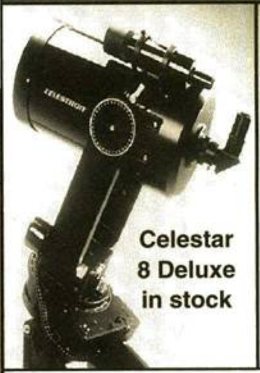
Meade ETX-90/EC
$595
+20 P & S

ETX accessories
#126 2x barlow $47.95
#64 Camera Adapter $29.95
ETX case $39.95

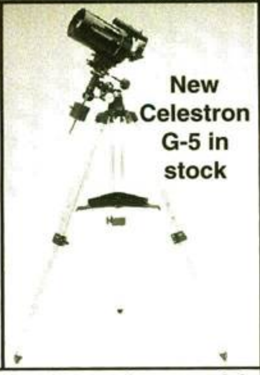
Most Meade Products in Stock/On Display!

- Meade Starfinder Dobsonians & Equatorials
- Meade LX50's
- 230, 390, 395, 4500's
- Meade Series 3000 and 4000 Eyepieces
- Most other Meade accessories in stock

AUTHORIZED CELESTRON® DEALER



Celestar 8 Deluxe in stock



New Celestron G-5 in stock

Most Celestron Products in stock!

- Celestron star hopper Dobsonians
- Celestar 8 SCT's
- C4.5, FS, 60, 80 + 114
- Ultima series Eyepieces
- LED flash lights
- F 6.3 reducer

"At Rivers we strive to give our customers the best service in the industry!"
Roger Rivers

Why Buy From Us?

- NE's Largest Telescope Display
- Mail-Order or In-Store. No Sales Tax!
- Used Scopes-Buy, Sell or Trade-In
- Knowledgeable, Helpful, Friendly Staff

TeleVue®

Rivers CAMERA SHOP
454 Central Ave.
Dover, NH 03820
Phone: (800) 245-7963 • Fax (603) 742-5456
www.riverscamera.com
Hours: M-TH 8:30-6:00, Fri. 8:30-8:00, Sat. 8:30-5:30

RADIO ASTRONOMY

Fleet Squeezes Telescope Time

▶ New telecommunications satellites have woven a web of radio noise that threatens to entangle studies of our galaxy. Astronomers have forged uneasy pacts with the satellite operators to work around this interference, but it's too early to say whether the agreements will succeed.

The noise comes from a $5.5-billion Motorola satellite fleet called Iridium. Starting in November, Iridium's 66 satellites beamed signals to mobile phones and pagers around the world. Some of Iridium's transmissions leak into a band reserved for radio astronomy at frequencies near 1612 megahertz (MHz) — swamping the faint radio wisps of cool dying stars and stellar nurseries. Even when the satellites aren't in service, they broadcast a constant homing signal that Michael Davis of the Arecibo Observatory in Puerto Rico calls a "dial tone in the sky."

Radio astronomers negotiated with Motorola to keep the signals below a key threshold during low-usage hours. In theory, this provides a quiet window at 1612 MHz for 8 hours a night at Arecibo and 4 hours at National Radio Astronomy Observatory facility in West Virginia. Research in other bands isn't affected by Iridium and can continue throughout the day.

"If these agreements are respected, it is my view that U.S. radio astronomers have struck a fairly decent deal," says Tomas Gergely, manager of the electromagnetic spectrum for the National Science Foundation.

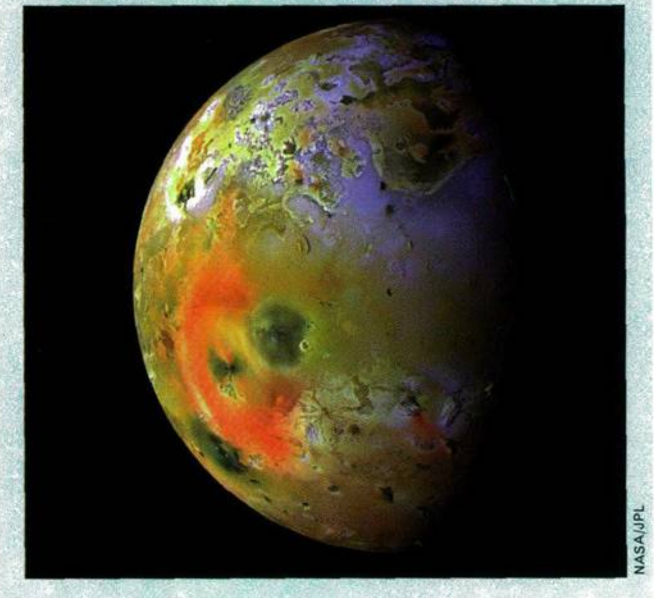
Davis, however, thinks the jury is still out. "The Iridium network isn't very busy yet," he says. "The broadcast tones are at a low level compared to what they will be when the system is fully loaded." Jack Wengryniuk, Iridium's executive director of licensing affairs, agrees but maintains that "Motorola will take the appropriate steps to meet our commitment as traffic increases." Astronomers also plan to step up their efforts to shield other parts of the radio spectrum from future encroachment.

— Robert Irion

When Iridium satellites reflect sunlight at just the right angle, they create flares (seen here). Radio astronomers, however, are less than thrilled.

Chris Dorreman

GALILEO



NASA/JPL

TURNING ITSELF INSIDE OUT. The most volcanically active object in the solar system, Jupiter's moon Io, continually spews sulfurous materials from dozens of volcanic vents. In this enhanced color composite from NASA's Galileo spacecraft, deposits of sulfur dioxide frost show either white or gray while the yellow and brown colors depict other sulfur compounds. The most recent volcanic activity appears reddish, such as the ring around the volcano Pele at lower left, or black, as in the 250-mile-wide deposit around Pillan Patera to Pele's upper right. Galileo should get its closest views of Io during flybys this October and November. If the spacecraft survives those encounters, the Galileo project has announced plans to extend the mission another year, continuing to monitor Jupiter and its moons until the Cassini mission passes by in December 2000 on its way to Saturn.

DARK MATTER

Looking for Ghosts

▶ More than a few people find the notion of dark matter hard to swallow. Although astronomers have found that 90 to 99 percent of the material in the universe emits no light — or so little light that it can't be detected — many still find the concept too bizarre to be true. Well, if the very idea of dark matter gives you pause, wait till you hear about the "ghost galaxies" that may outnumber the rest of the galaxies in the universe.

After studying dozens of galaxies ranging from the most luminous spirals to the faintest dwarfs, John Kormendy of the University of Hawaii and Kenneth Freeman of Mount Stromlo

Samy's Camera

200 South LaBrea Avenue
Los Angeles, CA 90036
800-321-4726
323-938-2420 • Fax: 323-937-2919

Visit Samy's Website: www.samys.com • E-mail Address: info@samys.com

CAMERAS • FILM • LIGHTING • RENTALS • DIGITAL IMAGING • VIDEO

CELESTRON Firstscope 60 $99.00

Firstscope 60 Deluxe Aluminum	$139.00
Firstscope 60 EQ Deluxe	$169.00
Firstscope 70 EQ	$239.00
Firstscope 80 EQ	$329.00

Just Arrived-Now In Stock!

Celestron CG 9¼ -	$2399.00
Celestron CM-1100	$3599.00
Celestron CM-1400	$5699.00

Complete Star Hopper Line Available!
4½" model starts at $209

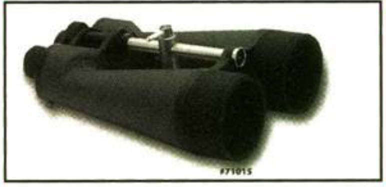
Star Hopper	
6"	$399
8"	$499
11"	$849
14"	$1099
17½"	$1999

New G-5 Now In Stock!

- Multicoated Optics
- Made in the USA
- German Equatorial Mount
- Models with Motor Drive
- Aluminum Tripod-Included Standard
- Easy Photo Adaptation
- CD-ROM Included

G-5 Telescope	$689.00
G-5 Telescope w/motor drive	$749.00

Celestar 8
in-stock! $1079

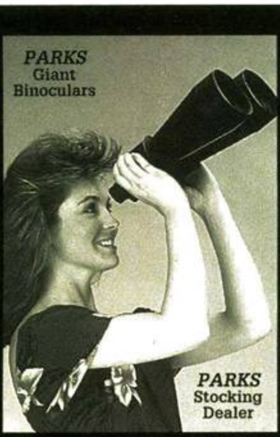


20x80 Giant DeluxeBinoculars-#71015
Now In Stock $419.00

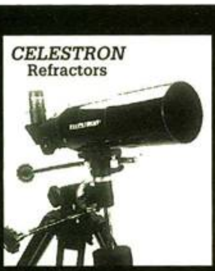
C102-HD
in-stock! $629

PENTAX Eyepieces In Stock! 5.2mm, 7mm, 10.5mm, 14mm, 21mm, 28mm, 40mm

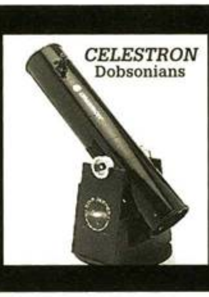
---



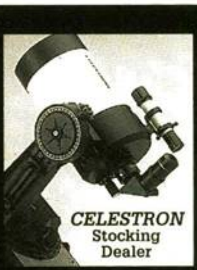
PARKS
Giant
Binoculars
PARKS
Stocking
Dealer



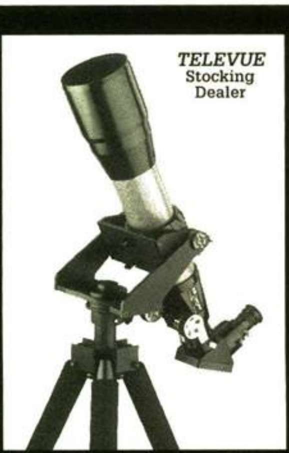
CELESTRON
Refractors



CELESTRON
Dobsonians



CELESTRON
Stocking
Dealer



TELEVUE
Stocking
Dealer

Scope City

Largest, Most Complete Optical Supermarket in the World

MAIN OFFICE
730 Easy Street
Simi Valley, CA 93065
TEL: (805) 522-6646

COSTA MESA, CA
3033 S. Bristol
TEL: (714) 957-6900

SHERMAN OAKS, CA
14324 Ventura Blvd.
TEL: (818) 789-5805

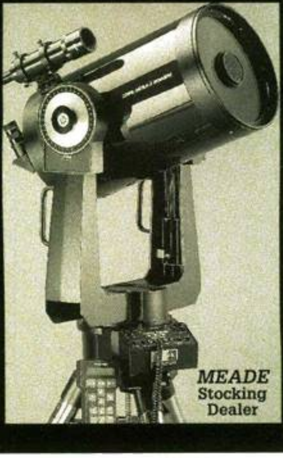
SAN DIEGO
4766 Clairemont
Mesa Blvd.
TEL: (619) 277-6686

SIMI VALLEY
730 Easy Street
TEL: (805) 522-6646

LAS VEGAS, NV
4825 W. Flamingo Rd.
TEL: (702) 947-2673

Scope City / Mail Order
P.O. Box 440, Simi Valley, CA 93062
TEL: (805) 522-6670
FAX: (805) 582-0292
Catalog package $7
(refundable with purchase)
Free price list.

Buy • Sell
Trade • Service



MEADE
Stocking
Dealer

Save up to 45% on Telescopes, Binoculars & Accessories

PARKS
16" F/5
Observatory

Observatory in Australia found that the bigger the galaxy, the lower the proportion of dark matter. The smallest dwarf galaxies typically have a density of dark matter 100 times that of a giant galaxy.

The smallest dwarfs, which can barely be discerned against the background sky, turn up in far larger numbers than bigger galaxies. If that trend continues, there may be a huge population of galaxies so ghostly that they can't be detected. Yet these galaxies contain significant amounts of dark matter.

Kormendy and Freeman think they understand why. Smaller galaxies possess a weaker gravitational field than their larger cousins. When the first massive stars exploded as supernovae, they ejected far more gas, leaving less to form future generations of stars. "These galaxies don't know that holding onto 1 percent of their mass in the form of gas is magic," says Kormendy. "It's turning that 1 percent into stars that allows us to discover them." The dark matter doesn't get blown away because it presumably exists in relatively small, dense objects or as particles that don't interact with other matter.

Is there any hope for finding these ghosts? The researchers suggest that the dark galaxies may contain about 10 million suns worth of material within a radius of a few hundred light-years. Although extraordinarily difficult to detect, they might turn up in computerized searches looking for very low star densities. As Freeman cautions: "It is a long way from predicting dark galaxies to proving that they exist. But looking for them may motivate a lot of astronomers."

SPACE MISSIONS

SOHO Back in Business

▶ Flight controllers have once again rescued the European Space Agency/NASA Solar and Heliospheric Observatory (SOHO). The $1-billion spacecraft had gone into a safe mode on December 21, 1998, when the last of its three gyroscopes failed. But by early February 1999, controllers had radioed new software that allowed SOHO to operate without any gyros — it's the first time a spacecraft built with gyros has successfully operated without any gyros.

"It's like instructing an airplane pilot from the ground to execute very complex maneuvers and helping him make a successful landing," says ESA SOHO program manager Michel Verdant. Adds ESA program scientist Roger Bonnet, "SOHO is back at work, and we're absolutely thrilled."

In other NASA news, Mars Global Surveyor entered its 250-mile-high circular mapping orbit in mid-February. The spacecraft is now in the midst of its primary mission of mapping the entire surface of Mars at high resolution. ■

WEBSITE

Check *Astronomy*'s website for news as it happens — http://www.astronomy.com.

Pluto Still a Planet

Pluto buffs take heart: Media reports that Pluto had been removed from the list of major planets were as presumptuous as the headline that screamed "Dewey Defeats Truman." The media reports were prompted by calls from several planetary scientists that Pluto be classified as a Trans-Neptunian Object (TNO). These scientists suggested that Pluto be classified as both a major planet and a TNO (see Ask Astro, page 96). In a press statement issued on February 3, the International Astronomical Union (the organization responsible for astronomical nomenclature) stated, "No proposal to change the status of Pluto as the ninth planet in the solar system has been made by any Division, Commission, or Working Group of the IAU responsible for solar system science."

Comet Catcher Underway

On February 7, NASA's latest Discovery spacecraft, Stardust, took off from Cape Canaveral for a January 2004 rendezvous with Comet Wild-2 (pronounced Vilt-2). The $165-million spacecraft will fly into the comet's tail, within 100 miles of the nucleus, where it will collect about 1,000 microscopic dust particles and return them to the Utah desert in January 2006. The samples will help scientists determine how much of a role comets played in delivering life's building blocks to Earth. Stardust will also collect and return interstellar dust samples. "Comets are the most carbon-rich materials in the solar system, and they're full of organic compounds and they fall on Earth all the time," says principle investigator Donald Brownlee of the University of Washington.

NASA

Stardust sits in a clean room at the Kennedy Space Center.

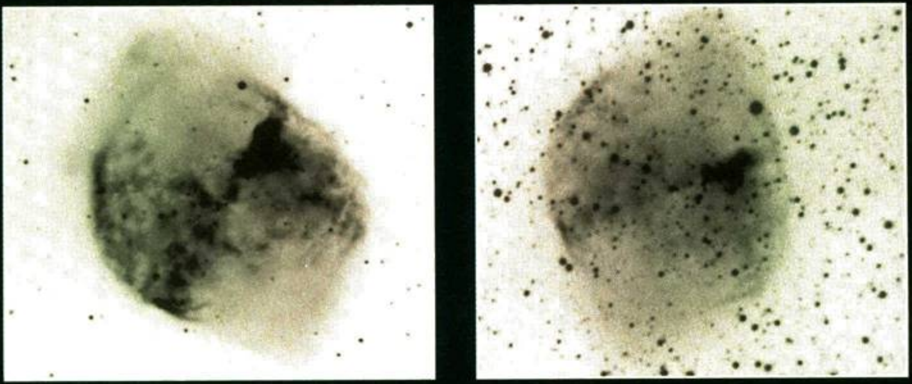
Mars on Earth

The Mars Society, an international group led by Robert Zubrin, plans to build a simulated Mars station right here on Earth. The complex will be built on Devon Island in the Canadian Arctic. Called The Mars Arctic Research Station, the compound will provide an environment to test living conditions on the Red Planet. Devon Island is a barren, cold land covered with ridges, valleys, and meteorite craters — as similar a place to Mars as anywhere on Earth. Here, scientists can test all-terrain vehicles, drilling equipment, water-recycling treatments, as well as the isolation and self-containment future explorers will experience on Mars.

SBIG
ASTRONOMICAL
INSTRUMENTS

IN EVERY FIELD THERE IS A LEADER

SBIG HAS COMBINED IMAGING AND AUTO-GUIDING



M27 Planetary Nebula. The large apparent size of this nebula classes it as probably one of the nearest of the planetaries at a probable distance of about 850 light years and about 2 1/2 light years in diameter. The central star, of magnitude 13.5, has about 1/2 the solar luminosity, if the adopted distance is reasonably correct. As in all planetary nebulae, the faint central star is an abnormally hot bluish dwarf or sub-dwarf with a spectrum resembling that of an ancient nova and a calculated surface temperature of about 85,000 deg. K, one of the hottest stars known. It is assumed that planetaries are formed by ejection of material from the hot central star, but the exact details of the process are unknown. ***The left image*** is a narrow band 3600 second CCD image taken with a Model ST-7 CCD Imaging Camera through an Ha filter. *Courtesy Benoit Schillings*. ***The right image*** is a 1200 second ST-7 CCD image taken through a 7", f/7 Astrophysics refractor. Both images utilized the self guiding mode. *Courtesy Tony Hallas.*

COMPARE

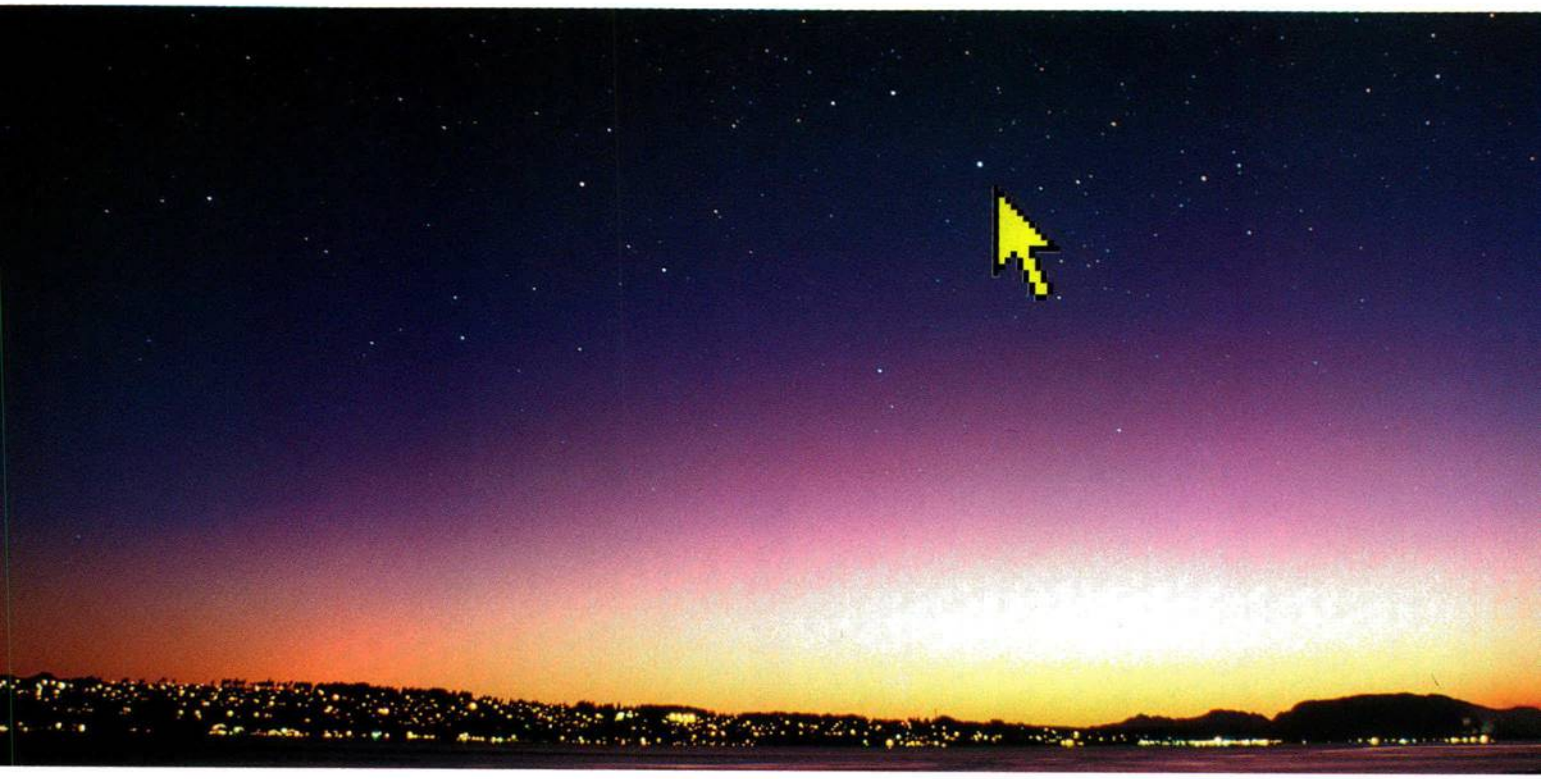
	Model ST-7	**Model ST-8**
Resolution	765 x 510 pixels	1534 x 1020 pixels
Total Pixels	390,000	1,500,000
CCD area	6.9 x 4.6 mm	13.8 x 9.2 mm
Celestron C-8 f.o.v.	12 x 8 arcminutes	24 x 16 arcminutes
Software	Windows & MSDOS	Windows & MSDOS
Color Filter Wheel	CFW-8	CFW-8

For catalog or demonstration disk contact:

SANTA BARBARA INSTRUMENT GROUP
P.O. Box 50437 1482 East Valley Road #33
Santa Barbara, CA 93150
Phone (805)969-1851 FAX (805)969-4069
e-mail: sbig@sbig.com Home address: www.sbig.com

SBIG
ASTRONOMICAL
INSTRUMENTS

Search Engine



Ultima® 2000: click, you're there.

Tackle the immensity of it all one click at a time with the Ultima® 2000 from Celestron, the legendary name in top-quality telescopes worldwide. This fully computerized, U.S.-made 8-inch Schmidt-Cassegrain is a sophisticated, powerful instrument, yet surprisingly easy to set up and use. To get started, just find any two alignment stars located on the star charts provided, and the Ultima® 2000 does the rest. After this simple procedure, even if you manually move the telescope, it will not lose its star alignment. A built-in 10,000+ object database includes the Sun and all major planets, the entire Revised NGC and Messier catalogs, and carefully selected objects from the IC, ESO and Uppsula catalogs. You access all computerized functions (position, speed, pointing, etc.) through a compact hand controller with an LED display. To locate an object, just press a button and the Ultima® 2000 finds it in seconds. It even displays useful facts about each object, such as right ascension and declination, magnitude, and size. Each optical system is individually hand figured, guaranteed to be diffraction limited and features multi-coated Starbright® coatings for maximum light transmission, and bright, high contrast images. And because they're Fastar compatible, CCD imaging with Celestron's optional PixCel 237 CCD Camera is a snap. Two whisper-quiet motors per axis are standard as well as precision worm gears for ultra smooth, accurate tracking. And with its remarkably rigid fork mount and sturdy, adjustable metal tripod, the Ultima® 2000 becomes one of the most complete, easiest to use go to systems in the market. Even the batteries are included. And with a total weight of only 49 pounds, "extremely portable" means just that. Visit your Celestron retailer or click on **www.celestron.com** for details. Celestron. Taking you where you've never been before©.

Ultima® 2000 specifications

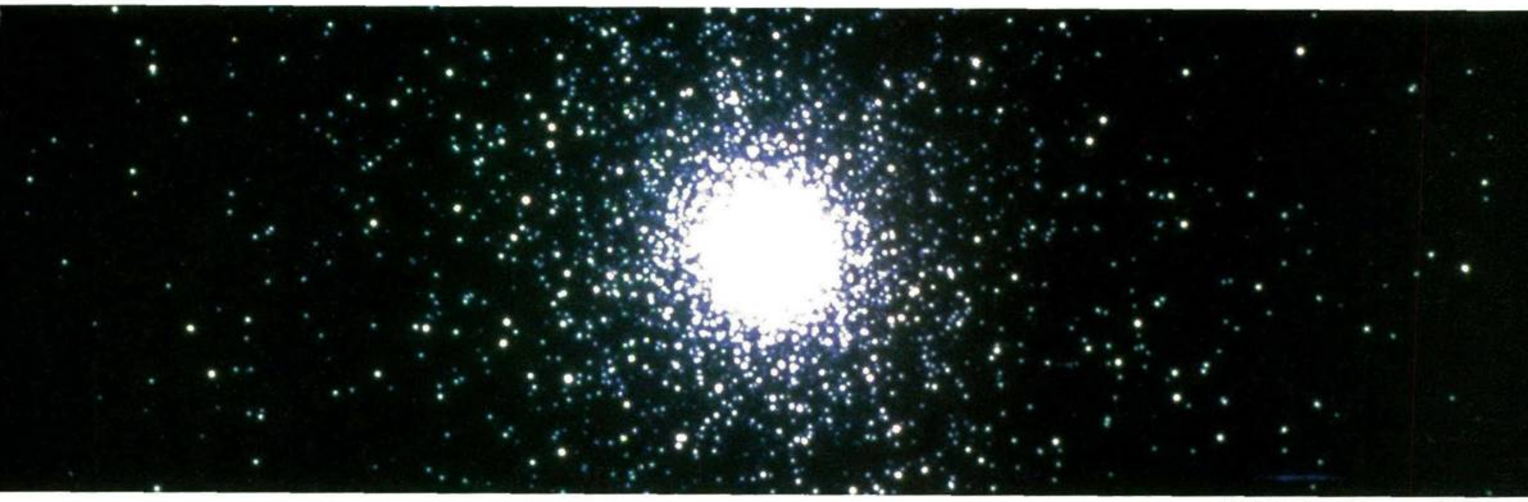
8" Schmidt-Cassegrain
2032mm Focal Length
Focal Ratio of f/10
Auto Guider Port
Northern and Southern Hemisphere Operation
Standard 1 1/4" Accessories:
  Multicoated 26mm Plössl Eyepiece (78x),
  Star Diagonal and Visual Back
9x50 Finderscope

CELESTRON®

2835 Columbia St., Torrance, CA 90503
Tel: (310) 328-9560 · Fax: (310) 212-5835
www.celestron.com

©1998 Celestron.

Energy cannot be created or destroyed.



Globular Star Cluster photo courtesy of NOAO.

But it can be stabilized.

Stabilize your viewing experience with an HD telescope from Celestron, the legendary name in top-quality telescopes worldwide. The HD series offers incredibly sturdy, "heavy duty" mounts at a surprisingly affordable price. In fact, *they are the most stable* and rigid in their class and price range. The mount's precision worm gears are extremely smooth in motion and the tracking accuracy is excellent. A special, hollow RA shaft allows for the insertion of an optional polar alignment scope. And of course, all HD series telescopes have diffraction-limited, premium optics manufactured to Celestron's uncompromising standards. The star images are classic textbook Airy disks. The mount's stability *makes it ideal for Astrophotography* with the addition of an optional motor drive. Visit your Celestron retailer or click on **www.celestron.com** for details. Celestron. Taking you where you've never been before®.

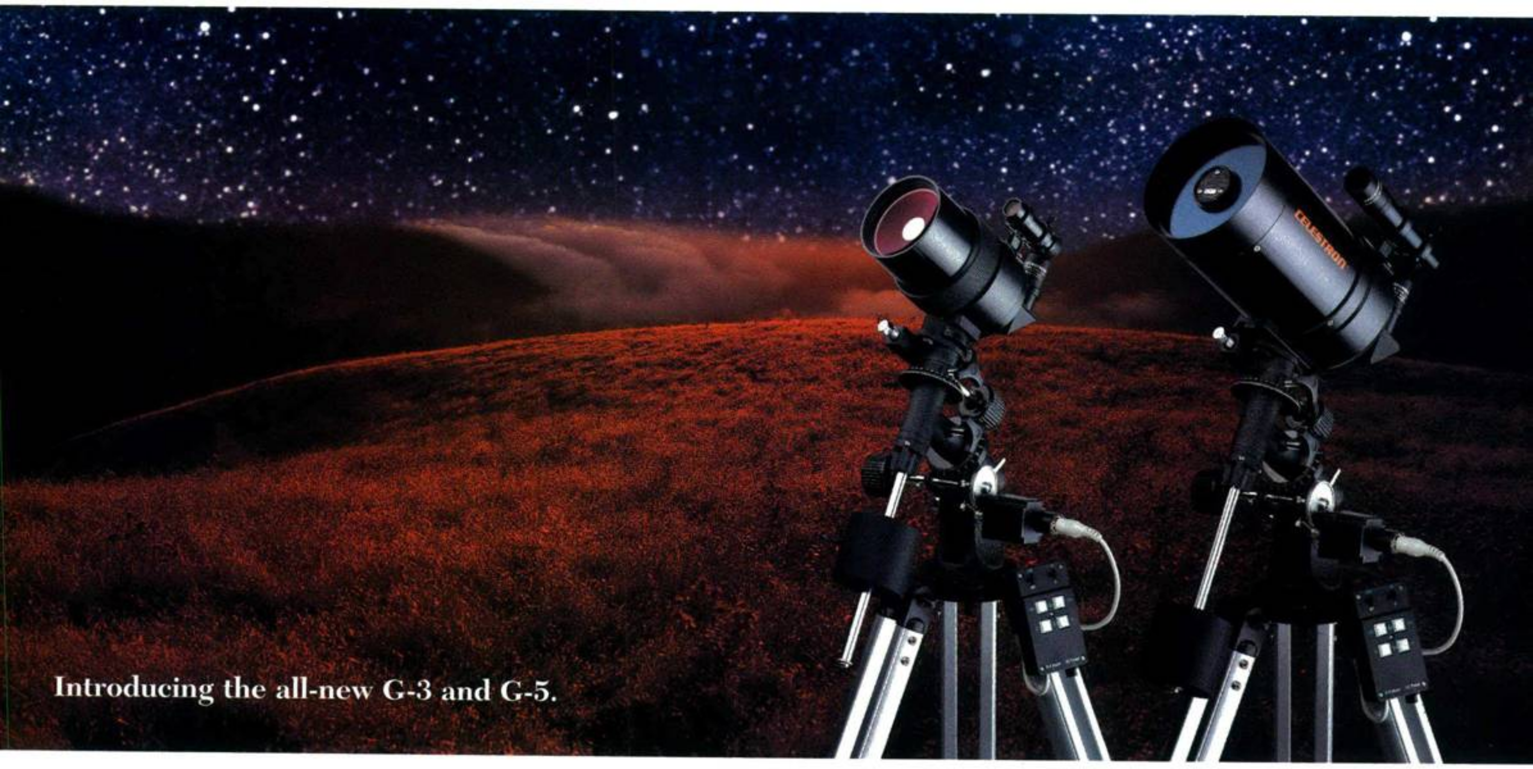
CELESTRON®

2835 Columbia St., Torrance, CA 90503
Tel: (310) 328-9560 · Fax: (310) 212-5835

	C80-HD	**C102-HD**	**C114-HD**	**C150-HD**
Aperture	80mm	102mm (4")	114mm (4.5")	150mm (6")
Focal Length	900mm	1000mm	900mm	1000mm
Focal Ratio	f/11	f/10	f/8	f/7
Optics	Fully Multi-coated	Fully Multi-coated	Multi-coated	Multi-coated
Finderscope	6x30	6x30	6x30	6x30
Accessories	Premium 20mm Plössl 1 1/4" eyepiece	Premium 20mm Plössl 1 1/4" eyepiece	Premium 20mm Plössl 1 1/4" eyepiece	Premium 20mm Plössl 1 1/4" eyepiece
Weights	29 lbs.	36 lbs.	28 lbs.	41 lbs.

The NEW C150-HD (#31056)
C114-HD (#31027)
C102-HD (#21016)
C80-HD (#21077)

Taking you where you've never been before©



Introducing the all-new G-3 and G-5.

Getting out there. Way, way out there. That's what it's all about. And now it's easier than ever with Celestron's ultraportable **G-3** and **G-5** telescopes. The perfect skywatching tools for amateur astronomers of all levels; whether you're a first-time user or a seasoned cosmic observer. From Saturn's rings to galaxies light years away to a bee buzzing in a patch of flowers, you'll enjoy brighter images, better contrast and sharper detail thanks to Celestron's legendary U.S.-made optics. Meticulously hand-crafted for optical excellence, the **G-3** and **G-5** are manufactured under the same strict quality standards found in our renowned C8 model. These large aperture, full-featured observation systems are ideal for terrestrial viewing and astrophotography and include tripod, accessory tray and CD-ROM software. All for less than you'd expect to pay. So pick one up and get out there. 'Cause there's a lot of "out there" to cover. For more information, visit your authorized Celestron retailer or see us on the Web: **www.celestron.com**

G-3 specs - #11090	**G-5 specs - #11050**
3 1/2" (90mm) Aperture	5" (127mm) Aperture
Maksutov-Cassegrain	Schmidt-Cassegrain
1000mm Focal Length	1250mm Focal Length
f/11 Focal Ratio	f/10 Focal Ratio
Multicoated Optics	Multicoated Optics
Light Grasp - 165x	Light Grasp - 330x
Resolving Power - 1.3 arc sec.	Resolving Power - 0.9 arc sec.
German Equatorial Mount	German Equatorial Mount
Aluminum Tripod & Accessory Tray	Aluminum Tripod & Accessory Tray
Weight: 4.0 lbs = Telescope	Weight: 5.3 lbs = Telescope
17.3 lbs = Telescope/tripod & mount	17.3 lbs =Telescope/tripod & mount
25mm SMA Eyepiece - 1 1/4" (40x)	25mm SMA Eyepiece - 1 1/4" (50x)
Field of View - 1.3°	Field of View - 1.0°
Eye Relief - 14mm	Eye Relief - 14mm
Near Focus - 5 ft.	Near Focus - 20 ft.
Optional Motor Drive available	Optional Motor Drive available

Enjoy great savings on a full line of customized G-3 and G-5 accessory packages! See your local Celestron dealer for details.

©1998 Celestron Models shown may be photographed with optional equipment.

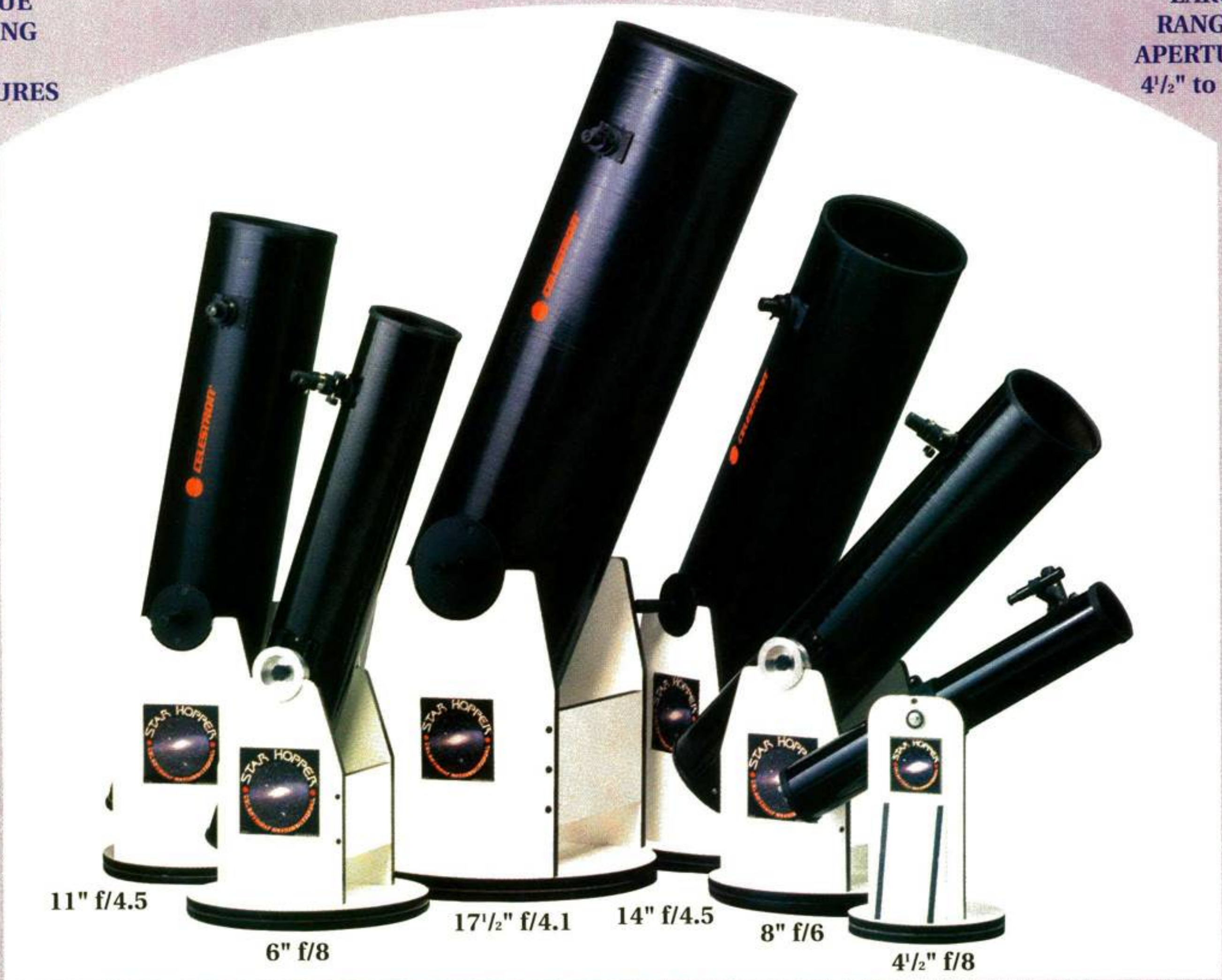
CELESTRON®

2835 Columbia St., Torrance, CA 90503
Tel: (310) 328-9560 · Fax: (310) 212-5835

CELESTRON® NEW STAR HOPPER® DOBS

UNIQUE STYLING and FEATURES

LARGEST RANGE OF APERTURES $4^1/_2$" to $17^1/_2$"



The 6" to $17^1/_2$" STAR HOPPERS have these Standard Features:

- Precision annealed Pyrex primary mirrors – better than glass used by competitors, ensure faster temperature stabilization and the highest quality steady optical figure.
- 25mm SMA Wide Angle Eyepiece – $1^1/_4$"
- $1^1/_4$" Rack and Pinion Focuser – 6" and 8"
- 2" Helical Focuser with $1^1/_4$" adapter – 11", 14", $17^1/_2$"
- Premium Quality, Affordably Priced
- Optics are diffraction limited.
- Multi-Coated Primary Mirrors
- 6" and 8" have a Unique Balance System.
- Teflon and Nylon surfaces guarantee smooth performing mechanics.
- Collimation Tool – very useful and unique to Celestron
- **Made in the U.S.A.**

SPECIAL OFFER ON ACCESSORY PACKAGES:

- Three different very economical packages.
- Buy packages from your Celestron dealer at your convenience – no time restriction.
- See your Celestron dealer or distributor for details on how to order.

PACKAGE A

✓ Includes a 10mm SMA Wide Angle Eyepiece – $1^1/_4$" Moon Filter – $1^1/_4$", 5x24 Finderscope with bracket, CD-Rom "The Sky for Celestron"

PACKAGE B

✓ Includes a 10mm SMA Wide Angle Eyepiece – $1^1/_4$" Moon Filter – $1^1/_4$", 6x30 Finderscope with bracket, LED Flashlight, Celestron Deluxe Sky Maps.

PACKAGE C

✓ Includes a 7.5mm Multi-Coated Plössl Eyepiece – $1^1/_4$", 17mm Multi-Coated Plössl Eyepiece – $1^1/_4$", 9x50 Finderscope with bracket, Night Vision Dual LED Flashlight, CD-Rom "The Sky for Celestron"

The $4^1/_2$" Star Hopper

comes standard with a 5x24 Finderscope, $1^1/_4$" Rack and Pinion Focuser, 25mm SMA Wide Angle Eyepiece – $1^1/_4$", and it comes Fully Assembled and ready to use.

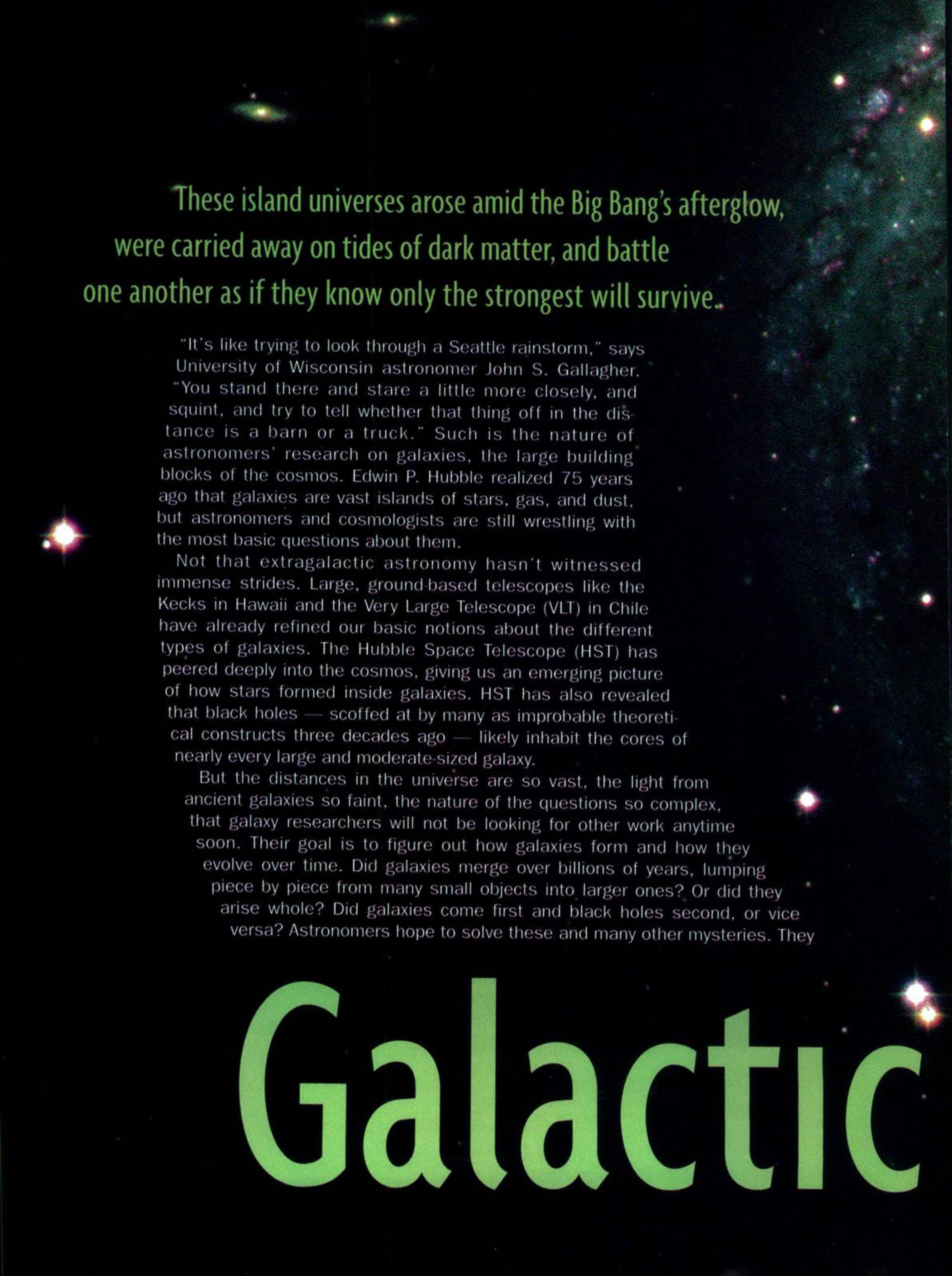
DROP SHIP ANY STAR HOPPER

from the Factory to anywhere in the U.S.A. (48 contiguous states). Pay only the exact shipping charges (freight collect) with **NO** extra handling or packing fees.

See your Distributor or Dealer about delivery in Alaska, Hawaii or other Countries.

CELESTRON® *For more detailed information on these telescopes, contact a Celestron dealer or Celestron. Visit our Web site at http://www.celestron.com*

Celestron International • 2835 Columbia Street, Torrance, CA 90503 • (310) 328-9560 • FAX (310) 212-5835



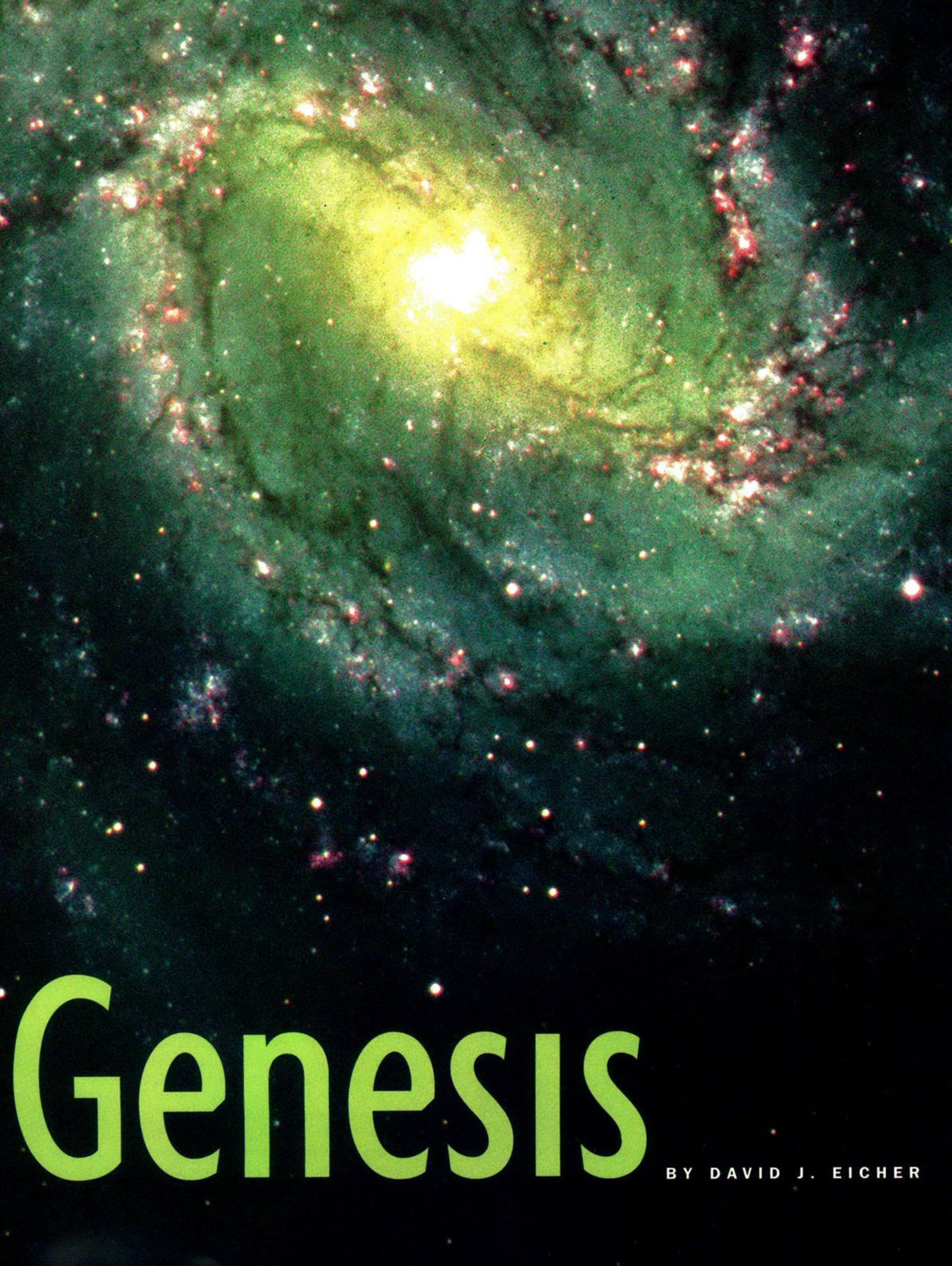
These island universes arose amid the Big Bang's afterglow, were carried away on tides of dark matter, and battle one another as if they know only the strongest will survive.

"It's like trying to look through a Seattle rainstorm," says University of Wisconsin astronomer John S. Gallagher. "You stand there and stare a little more closely, and squint, and try to tell whether that thing off in the distance is a barn or a truck." Such is the nature of astronomers' research on galaxies, the large building blocks of the cosmos. Edwin P. Hubble realized 75 years ago that galaxies are vast islands of stars, gas, and dust, but astronomers and cosmologists are still wrestling with the most basic questions about them.

Not that extragalactic astronomy hasn't witnessed immense strides. Large, ground-based telescopes like the Kecks in Hawaii and the Very Large Telescope (VLT) in Chile have already refined our basic notions about the different types of galaxies. The Hubble Space Telescope (HST) has peered deeply into the cosmos, giving us an emerging picture of how stars formed inside galaxies. HST has also revealed that black holes — scoffed at by many as improbable theoretical constructs three decades ago — likely inhabit the cores of nearly every large and moderate-sized galaxy.

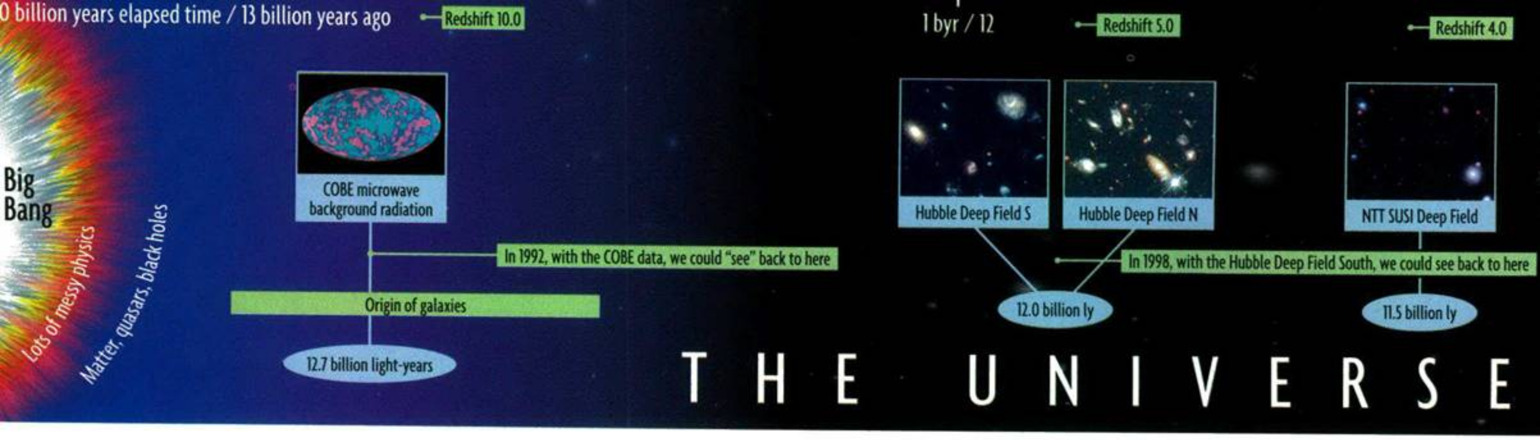
But the distances in the universe are so vast, the light from ancient galaxies so faint, the nature of the questions so complex, that galaxy researchers will not be looking for other work anytime soon. Their goal is to figure out how galaxies form and how they evolve over time. Did galaxies merge over billions of years, lumping piece by piece from many small objects into larger ones? Or did they arise whole? Did galaxies come first and black holes second, or vice versa? Astronomers hope to solve these and many other mysteries. They

Galactic



Genesis

BY DAVID J. EICHER


0 billion years elapsed time / 13 billion years ago
Redshift 10.0
1 byr / 12
Redshift 5.0
Redshift 4.0
Big Bang
Lots of messy physics
Matter, quasars, black holes
COBE microwave background radiation
In 1992, with the COBE data, we could "see" back to here
Origin of galaxies
12.7 billion light-years
Hubble Deep Field S
Hubble Deep Field N
NTT SUSI Deep Field
In 1998, with the Hubble Deep Field South, we could see back to here
12.0 billion ly
11.5 billion ly
THE UNIVERSE

Left to right: COBE: NASA; Hubble Deep Field South: HST/Robert Williams, STScI, and NASA; Hubble Deep Field North: HST/Robert Williams, STScI, and NASA; NTT SUSI Deep Field: NTT/ESO; Young Galaxy Survey: HST/Rogier Windhorst and Sam Pascarelle, STScI, and NASA; Sculptor galaxy cluster: HST/Duccio Machetto, Mauro Giavalisco, STScI, and NASA; MG0414+0534: VLT/ESO; Deep Field around 53W002: William Keel, University of Alabama. Background illustration: *Astronomy:* Elisabeth Rowan

want to reconcile the pinwheels and spheres of stars we see near us today with the stuff that preceded them — the fuzzy fragments and blobs visible in the deepest images of the primordial universe. It's a grand story with an unwritten ending. Seventy-five years after Hubble, astronomers are on the edge of forever.

Have I Got a Merger for You!

Walter Baade was the first astronomer to study the formation of galaxies by examining their stars. Baade, one of the premier researchers at California's Mt. Wilson Observatory by the early 1950s, discovered a group of stars around the Milky Way with very few metals, elements heavier than hydrogen and helium. These stars are ancient, probably older than 11 billion years. Metals that were thrown out into interstellar space by supernovae and other processes were eventually incorporated into younger stars in our galaxy.

Baade's discovery led to a model of galaxy formation in the 1960s nicknamed ELS, after Olin Eggen, Donald Lynden-Bell, and Allan Sandage, the astronomers who proposed it. The ELS model says galaxies collapse as single objects out of gas clouds. As the gas fell in by gravity, it first formed a spheroidal halo. As more gas coalesced, it began spinning and was enriched with metals, creating disks inside galaxies.

A different, recently proposed idea is the merger theory. It could have been hatched on Wall Street where the merger buzz is about AOL with Netscape and Exxon with Mobil. But those mergers are minuscule in size compared with the unions of protogalaxies, blobs of gas without stars that gravitated together and merged to form the galaxies in the early universe, and galaxies of various sizes merging later with other galaxies. "Mergers may be the key to understanding galaxies," says Bill Keel of the University of Alabama. "We see them taking place in the nearby universe, and they also were the primary way to make galaxies in the ancient universe."

The Sc galaxy NGC 2997 in Antlia has a ring of gas around its nucleus. Smaller than the Milky Way, it contains about 100 billion stars.

Unless otherwise noted: David Malin/Anglo-Australian Telescope Board

Indeed, over the past few years it has become increasingly clear that many galaxies, perhaps the vast majority, formed as small gas clouds came together, merging into larger and larger galaxies as time went on. This is called the small-to-big path.

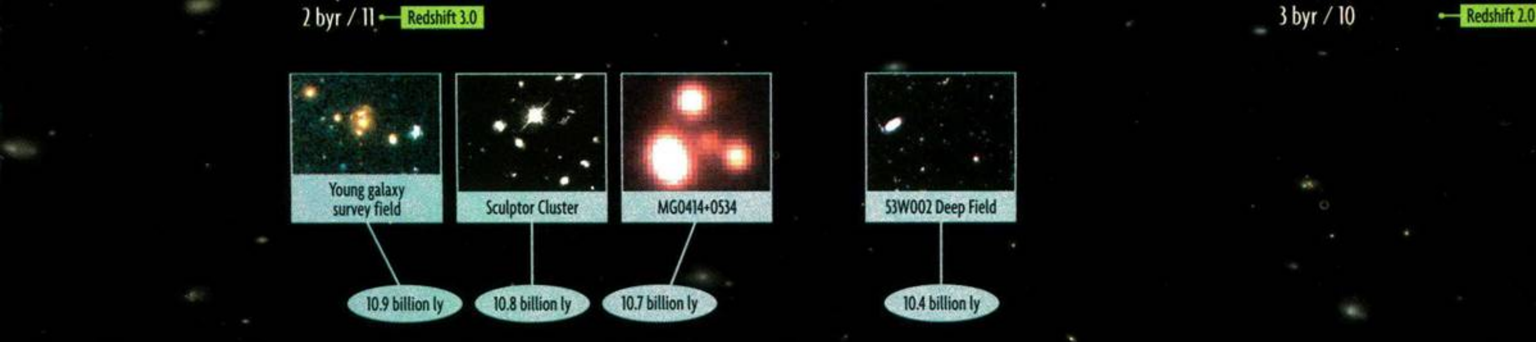
"We don't really know which is the dominant path yet," says Gallagher. "There's a strong theoretical prejudice to make small things and have them grow bigger, by having gas fall into them or by capturing their neighbors. But astronomers haven't yet proven that this is the main way it happens."

However, circumstantial evidence that merging is the primary mode of galaxy formation is accumulating. The two Hubble Deep Fields reveal numerous small galaxies. These are likely the small galaxies that joined together to build bigger ones.

In January, Trevor Ponman of Birmingham University and others used the ROSAT x-ray observatory to monitor the temperatures in hot gas surrounding galaxies in clusters. Ponman found that the temperatures could be produced by supernovae if galaxies formed before they grouped together into clusters. This supports the small-to-big scenario. Other astronomers are trying to confirm his results.

To figure out how galaxies formed, astronomers need to know what kind of a universe exists. Most astronomers assume the universe formed roughly 13 billion years ago and has cooled and expanded ever since. The infant universe was a uniform sea of several-thousand-degree gas and dark matter, the unseen, mysterious, and much more predominant form of matter that is indirectly known to exist because of its huge gravitational influence on galaxies. Subatomic particles formed quickly, which condensed into atoms a few minutes after the Big Bang. However, the wild card is dark matter.

"We are still in the dark ages," says astronomer Vera Rubin of the Carnegie Institution of Washington. "We do not know which came first, dark matter, black holes, or stars." Astronomers don't yet know what dark matter is made of, but theory and observation have combined to point toward an early universe dominated by one variety of it, so-called



AT A GLANCE

A ROGUE'S GALLERY OF GALACTIC ODDITIES

UNRELIABLE COUSIN

BL Lacertae. BL Lacertae objects, named for what was first thought to be an erratic variable star, are quasar-like galaxies on a less energetic scale (like the odd relative who's always in the background).

MEEK BYSTANDER

Leo A. Dwarf galaxies are small, quiet, and stuck in dimly lit corners of the universe. They contain mostly old stars, although some appear to be acquiring gas that enables new rounds of star formation.

SOCIAL CLIQUE

Stephan's Quintet. Some people hang out with a select few; so do some galaxies. The Milky Way is a member of the Local Group of galaxies, an aggregation of only 35 galaxies that is vastly smaller than a galaxy cluster.

HERMIT

UKS1927–177. Low surface brightness galaxies hardly get noticed. They are scattered throughout the universe but simply contain so few stars and so little gas they glow dimly. They're shy, always hiding in their rooms.

OVERACHIEVER

OQ 172. Quasars are the extraordinarily bright centers of young galaxies. Powered by central black holes, they emit vast quantities of energy into the universe. By their brilliance, quasars show the whole universe all they can.

CAR-CRASH VICTIM

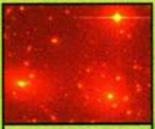
NGC 1143. Ring galaxies are the prettiest crash victims in the universe. A head-on collision with a high-speed galaxy that passed directly through its center creates a band of newly formed stars that encircles the galaxy's battered hub.

FERTILE MOTHER

M82. Some galaxies produce lots of infant stars. The cause may be chains of supernovae or simply ordinary physics that compresses gas, setting off waves of star births in newly bright spiral arms.

BULLY

NGC 4889. cD giant elliptical galaxies are the largest galaxies in the universe, giant ellipticals generally inhabiting the centers of dense clusters. They are the bullies of the cosmos, growing by cannibalizing smaller galaxies.


OMNIPRESENT

Coma Berenices Galaxy Cluster. You know the family that sticks around on the couch long after the football game's over? Galaxy clusters approximate this tense environment with a crowd of ellipticals and lenticulars.

STAR-CROSSED LOVERS

NGC 2207. Like lovers locked in a torrid embrace, galaxies sometimes gravitationally intertwine, leaving themselves forever altered by the experience. These encounters often create mergers, setting off starbirth fireworks.

ODDBALL

NGC 520. Some galaxies are just weird. Peculiar galaxies may be the survivors of ancient galactic encounters gone bad. They may be the victims of excessive disruption by gravitational tugs, star clusters, supernovae, or black holes.

PUMPED-UP ATHLETE

NGC 1316. They may look ordinary from the outside, but radio galaxies are high-energy objects that have exploded, hide black holes or eject invisible lobes of energy from their poles. Think of a flexing, pumped-up bodybuilder.

GI PATIENT

NGC 3783. Seyfert galaxies, named for Carl K. Seyfert, are set apart by fast-moving, hot gas swirls around their centers. Remember Uncle Charley's condition after he ate too much at the county fair?

All images courtesy Digital Sky Survey, except for M82 image and the Coma Cluster, courtesy William Keel, University of Alabama

4 byr / 9

A Brief Lesson in Lookback Time

As we look deeper into the universe, we're looking back in time. From an observational standpoint, those of us with backyard telescopes are limited. Virtually all of the bright galaxies visible are less than 300 million light-years away – all the Messier and NGC galaxies and most of the obscure ones, too.

The most distant bright clusters of galaxies visible in backyard CCD cameras, such as the Corona Borealis Galaxy Cluster, are about one billion light-years away. Farther back, as measured by redshifts, the degree to which galaxies's light is shifted toward longer, redder wavelengths, astronomers have not extensively targeted the moderately distant universe. They pick up again with the emphasis on finding extremely distant galaxies, as with the Hubble Deep Fields, which see back to a redshift of 5, corresponding to only one billion years or so after the Big Bang. The era of galaxy formation probably began between 200 million years and one billion years after the universe came to be. The desire to understand the processes drives a good deal of galaxy research today.

cold dark matter. This stuff consists of particles that moved around groggily until galaxies started to form. The cosmological implication of this model is that galaxies would form hierarchically, with smaller objects clumping together to form larger ones.

A competing minority view favors the hot-dark-matter model. This theory suggests that speedier particles zipped about and led to the formation of big sheets or pancakes of collapsed matter and galaxies assembled inside them.

Whichever kind or kinds of dark matter existed, the key question is how the universe went from smooth to lumpy with galaxies. "About 100,000 years after the Big Bang the universe had few features larger than tiny ripples on a lake," says Chris Impey of the University of Arizona. "Over hundreds of millions of years, gravity sculpted the ripples into features large enough to collapse into galaxies."

A milestone for this idea came in 1992 when NASA's Cosmic Background Explorer satellite observed the ripples as tiny fluctuations in the temperature of the primordial universe. The ripples echoing from the Big Bang are the so-called cosmic microwave background radiation. Produced about 300,000 years after the Big Bang, the temperature fluctuations carry the first imprint of clumpiness that might have led to the first galaxies. That means dark matter was the omnipresent backdrop that came first and all structures were anchored to it. In other words, galaxies are like the whitecaps on a sea of dark matter. "In a way, galaxies are a distraction," says Impey. "The stars in all of them amount to only 0.3 percent of the mass of the universe."

The brightest member of a sparse group of nearby galaxies, Sculptor's NGC 300 shows itself as it was about 8 million years ago.

Left to right: 3C 324: HST/Mark Dickinson, STScI, and NASA; EIS 0046-2930: VLT/ESO

Modeling How Galaxies Came Together

Astronomers study the formation of the first galaxies with fossils and a time machine. They pick apart nearby galaxies in exquisite detail, as if they were fossils, to understand the chemistry of star formation and galaxy evolution. They use computer models as time machines, running them forward and backward to examine the current universe and earlier epochs.

The process is a joint venture between observers and theoreticians. The observers use two basic and complementary techniques to observe properties of early galaxies. First, they look at the properties of old stars in nearby galaxies, stars that formed in the ancient universe and that can be studied individually and at relatively close distances. They also directly observe objects at great distances, viewing whole young galaxies or protogalaxies, many of which contain quasar nuclei. Quasars are the central black holes of young galaxies that spew vast quantities of radiation.

Theoreticians use supercomputers to run numerical simulations to show how dark matter — whatever it is — might have come together to form the gravitational wells that likely preceded galaxies. So-called hydrodynamic simulations trace how everything that shines in galaxies, which is regular or baryonic matter, behaves as gas and stars.

After dark matter formed, what formed next — galaxies or black holes? Martin Rees, Martin Haehnelt, Priya Natarajan, and others try to answer that question with phenomenological models.

"We think that black holes assembled quite early, but stars probably came first," says Natarajan of the Canadian Institute for Theoretical Astrophysics. "A small fraction of the stars in a galaxy formed very early in the history of time. A black hole was probably simultaneously forming. As material falls into the black hole, high-energy particles are emitted as a byproduct, and it soon outshines the whole galaxy as a quasar. The rest of the protogalaxy forms around the quasar, either by mergers or as collapsing gas is converted into stars."

Theoretician Joseph Silk of the University of California agrees. "The usual view is that stars formed first," he says, "and the debris from aging and colliding stars eventually accumulate in the center of the galaxy to form a massive black hole."

Silk's galaxy simulations populate the universe with young spirals and ellipticals so that the more remote the galaxy, the

5 byr / 8
Redshift 1.0
6 byr / 7
3C 324
EIS 0046-2930
7.7 billion ly

more youthful it is. Next, he generates an image of the distant universe as it would be seen by HST. Then he compares the simulation with reality to determine whether or not the model duplicates what astronomers see. He repeats the process until the simulations fit the observational data.

Unfortunately, most galaxy models can't model mergers. The current trend in galaxy theory, however, is semi-analytic modeling, an approach of doing as much as possible with equations rather than with computer simulations. Three groups are using this modeling technique: a group led by Simon White at the Max Planck Institute for Astrophysics in Munich, another led by Carlos Frank at the University of Durham, England, and another led by Joel Primack at the University of California, Santa Cruz.

Semi-analytic modeling is intended to show how gas cools into a galactic disk and how that condensation generates star formation. High-mass stars function as helpful markers because they produce supernovae and more ultraviolet light than that produced by low-mass stars. But the modelers don't know the original ratio of high-mass stars versus low-mass stars, so they estimate. "At this stage all we can do is to try several variations and see which best fits the data," says Primack. His simulations, which are completed in a few hours on a fast workstation, include 100,000 galaxies in a model universe.

"You can actually learn a lot of physics from them," says Natarajan. "The amazing thing is that they put in 10 or 11 *ingredients* and they can successfully explain a lot of what is observed. They can actually give you a story line. You can fit the pieces, but you can't yet understand the whole picture."

Primack has faith in the refinement of the semi-analytic process. "The key point of this whole thing is coming to an understanding of how the input assumptions lead to the output results," he says. "When we compare them to observations, we get some way of interpreting what's happening in the real universe."

Other simpler modeling can describe relatively small volumes of space about 30 million light-years across. However, semi-analytic modeling can depict much larger volumes of space and resolve thousands of little galaxies and how they merge over time. It also follows groups of stars that form within galaxies over the entire range of cosmic history. "It's basically a bookkeeping chore," says Primack. "But one that ultimately may tell us how galaxies formed."

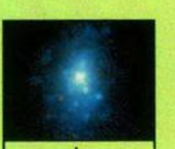
How Old Is Old?

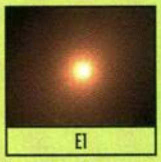
The birth date of the first galaxies is another mystery. It appears the first big epoch of galaxy formation took place between 300,000 and one billion years after the Big Bang. Like planets, galaxies were born in various sizes and were variously shaped by quiet isolation, mergers, or by the big

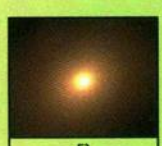
PINNING DOWN GALACTIC FORMS

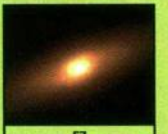
Even before astronomers recognized that galaxies were distant islands of stars and gas, they set out to categorize them. They did so just as an entomologist would pin butterflies or beetles, species by species, into a display case. With galaxies, the basic system devised 75 years ago by Edwin Hubble is still used. Of course as astronomers are able to look further back in time, the number of specimens in the display case has increased. Galaxies in the recent universe a couple billion light-years from Earth fall into five classes of structure, each of which almost certainly formed from the mergers of many smaller galaxies and protogalaxies:

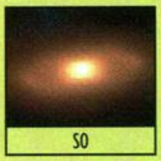
- Ellipticals, roughly spherical assemblages of mostly old stars, are gas-poor and span a range of shapes from E1 (spherical) to E7 (flattened, oblate halos).
- Lenticular (S0), or lens-shaped, galaxies superficially resemble flattened ellipticals except that they contain a disk component without spiral arms.
- Galaxies that formed close to others spun, forming prominent spiral and barred spiral disks. Spiral galaxies are classified from Sa (bright, prominent centers with tightly wound, thin arms) to Sd (meekly glowing centers with loosely wrapped arms).
- Barred spirals are similarly organized from SBa to SBd. The bluish disks of spirals and barred spirals are home to gas clouds in which many stars are coming to life.
- Irregular galaxies (Ir) defy any organization: They are chaotic splashes of stars and gas that lack organized structure.

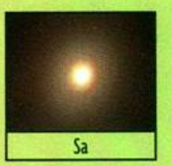

Ir
NGC 5204 in Ursa Major

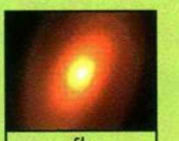

E1
NGC 4636 in Virgo

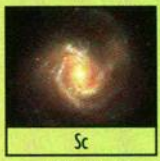

E3
M86 in Virgo

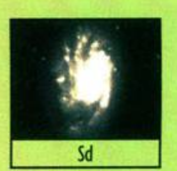

E7
NGC 4526 in Virgo

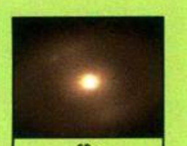

S0
NGC 4429 in Virgo

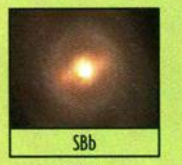

Sa
NGC 2775 in Cancer

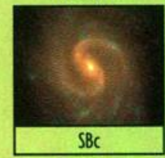

Sb
M81 in Ursa Major

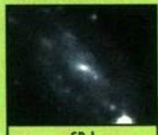

Sc
M61 in Virgo


Sd
NGC 1494 in Horologium

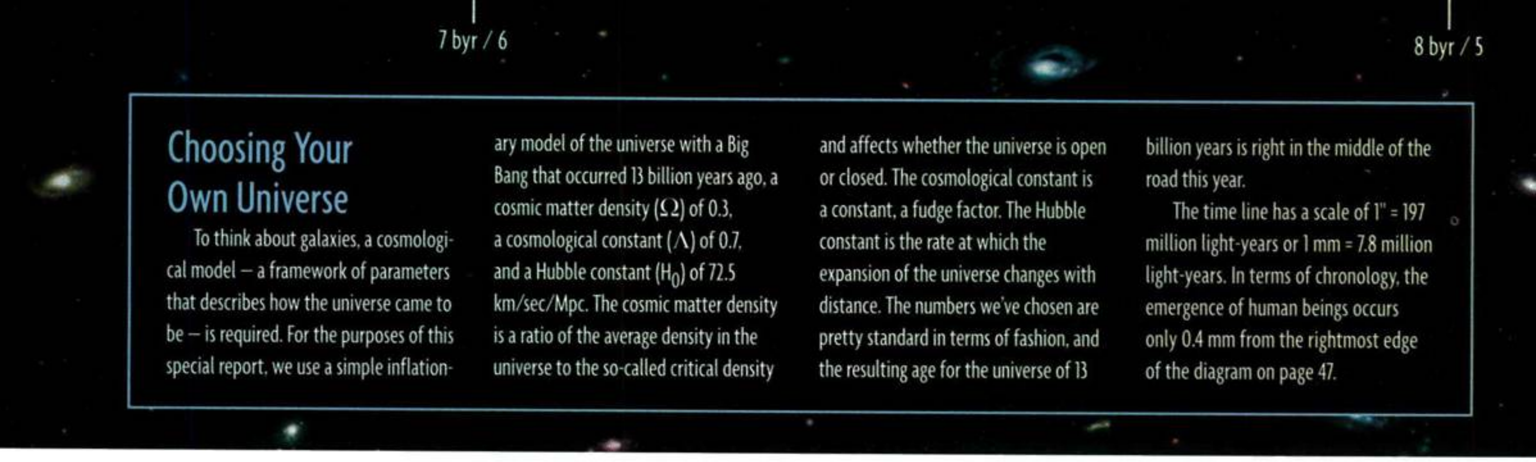

SBa
NGC 4340 in Coma Berenices


SBb
M95 in Leo


SBc
NGC 4535 in Virgo


SBd
NGC 2273B in Lynx

All images courtesy Zsolt Frei and James E. Gunn, *The Galaxy Catalog*, Princeton University, except for NGC 1494 and NGC 2273B, which are courtesy Digital Sky Survey



Choosing Your Own Universe

To think about galaxies, a cosmological model – a framework of parameters that describes how the universe came to be – is required. For the purposes of this special report, we use a simple inflationary model of the universe with a Big Bang that occurred 13 billion years ago, a cosmic matter density (Ω) of 0.3, a cosmological constant (Λ) of 0.7, and a Hubble constant (H_0) of 72.5 km/sec/Mpc. The cosmic matter density is a ratio of the average density in the universe to the so-called critical density and affects whether the universe is open or closed. The cosmological constant is a constant, a fudge factor. The Hubble constant is the rate at which the expansion of the universe changes with distance. The numbers we've chosen are pretty standard in terms of fashion, and the resulting age for the universe of 13 billion years is right in the middle of the road this year.

The time line has a scale of 1" = 197 million light-years or 1 mm = 7.8 million light-years. In terms of chronology, the emergence of human beings occurs only 0.4 mm from the rightmost edge of the diagram on page 47.

Left to right: Sun and planets: Mark Paternostro; CL 0939+4713: HST/Alan Dressler, STScI, and NASA; Abell 370: VLT/ESO; Ancient microfossil: William Schopf/UCLA

devouring the small. Most astronomers thought that elliptical galaxies had been around since the beginning of the universe and hadn't changed since then. "We now know that ellipticals have a variety of shapes and structures," says Gallagher, "and some of them have clearly eaten other galaxies in the recent past. They have gas floating around them and material rotating in the wrong directions."

Galaxies seem to be reluctant to reveal their pasts. It's hard to tell the difference between a galaxy that stopped making stars 10 billion years ago and one that stopped four billion years ago. "The once-accepted idea that if something looks old, it is old," says Gallagher, "is probably wrong."

Big ellipticals, such as M87 in Virgo and others that inhabit rich clusters, probably formed in the very early days of the universe either by collapsing or merging. Recent observations with SCUBA, the submillimeter camera on the 15-meter James Clerk Maxwell telescope, suggest that big collapses shrouded in dust may have formed these ellipticals, says John Kormendy of the University of Hawaii.

However, not all ellipticals are ancient. "They are also forming now, when big galaxies collide violently and merge," says Kormendy. "It's tempting to describe ellipticals in two classes — early and late." One of the brightest galaxies visible in the southern sky, Centaurus A, is the result of a catastrophic merger that took place one billion years ago. On the other hand, most spiral galaxies probably formed by mergers of protogalactic lumps into bigger and bigger galaxies.

Astronomers believe that most medium and large galaxies, the Andromeda Galaxy included, have slumbering black holes in their centers.

At redshifts larger than 1, an astronomical measure that extends back to half the universe's age, spirals look quite different than they do billions of years later; there are more irregular and smaller galaxies. Thus, spiral galaxies must have evolved radically over the ages. While astronomers observe stars in the Milky Way that are 12 billion years old, whose nuclear fires initially sparked in the first era of galaxy formation, the Milky Way didn't have a nice spiral disk back then.

A majestic barred spiral such as the Milky Way may have existed in its early days as dozens or hundreds of pieces that coalesced during the last few billion years. During this time the sun and planets formed and life arose on our little blue planet — inside a galaxy that looked very different than it does today.

Some galaxies also combine the traits of the major types. "There are spheroidals," says Kormendy. "They are superficially like ellipticals but on closer inspection are more like irregulars. They appear to have formed gradually from smaller spiral and elliptical galaxies by starbursts, ejection of gas, and 'galaxy harassment' — the continuous removal of gas and stars from nearby galaxies." (See "A Rogue's Gallery of Galactic Oddities," p. 41.)

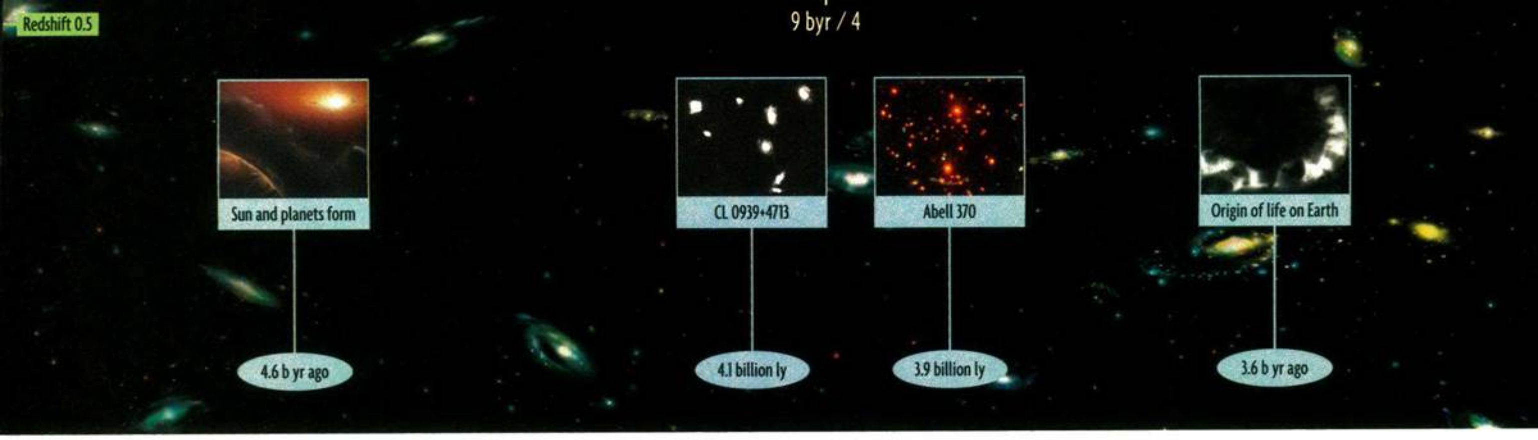
The consensus among astronomers is that there are two types of ellipticals. Astronomers also think mergers sculpt most galaxies. But nature always turns out to be more complicated than scientists think. "We imagine that one type of galaxy can't turn into another," says Impey, "but interactions and mergers clearly alter many galaxies."

Astronomers observe galaxies in the distant universe as they were 8 to 10 billion years ago, and they know that whatever went on at those times is linked with the forms that arose later. So far, though, they have been unable to make all the evolutionary connections.

How Galaxies Change over Time

Astronomers know that big galaxies tend to form early. Globular clusters tell them so: The stars in globular clusters in the Milky Way, for example, are ancient. The Milky Way, then, in some form, is itself ancient. The Large Magellanic Cloud, the Milky Way's satellite, also is ancient. The Andromeda Galaxy is ancient. By extension, it's clear that portions of big spirals formed early on, perhaps as early as some of the ellipticals.

"The big difference is that for the ellipticals, by the time they reached middle age, it was all over," says Gallagher. "Most of them had formed most of their stars." Astronomers think spirals probably formed one-quarter to



three-quarters of their stars early on and the disks of gas in spirals continue to create stars. They think supernovae and density waves inside spirals collapse gas and lead to star formation. However, if gas is left alone, it cools and condenses on its own to make stars.

What drives some galaxies to form stars at certain times is a mystery. Astronomers can't predict the form a given galaxy will take in three billion years. It's like weather prediction: Astronomers know roughly what will happen but they don't know the specifics.

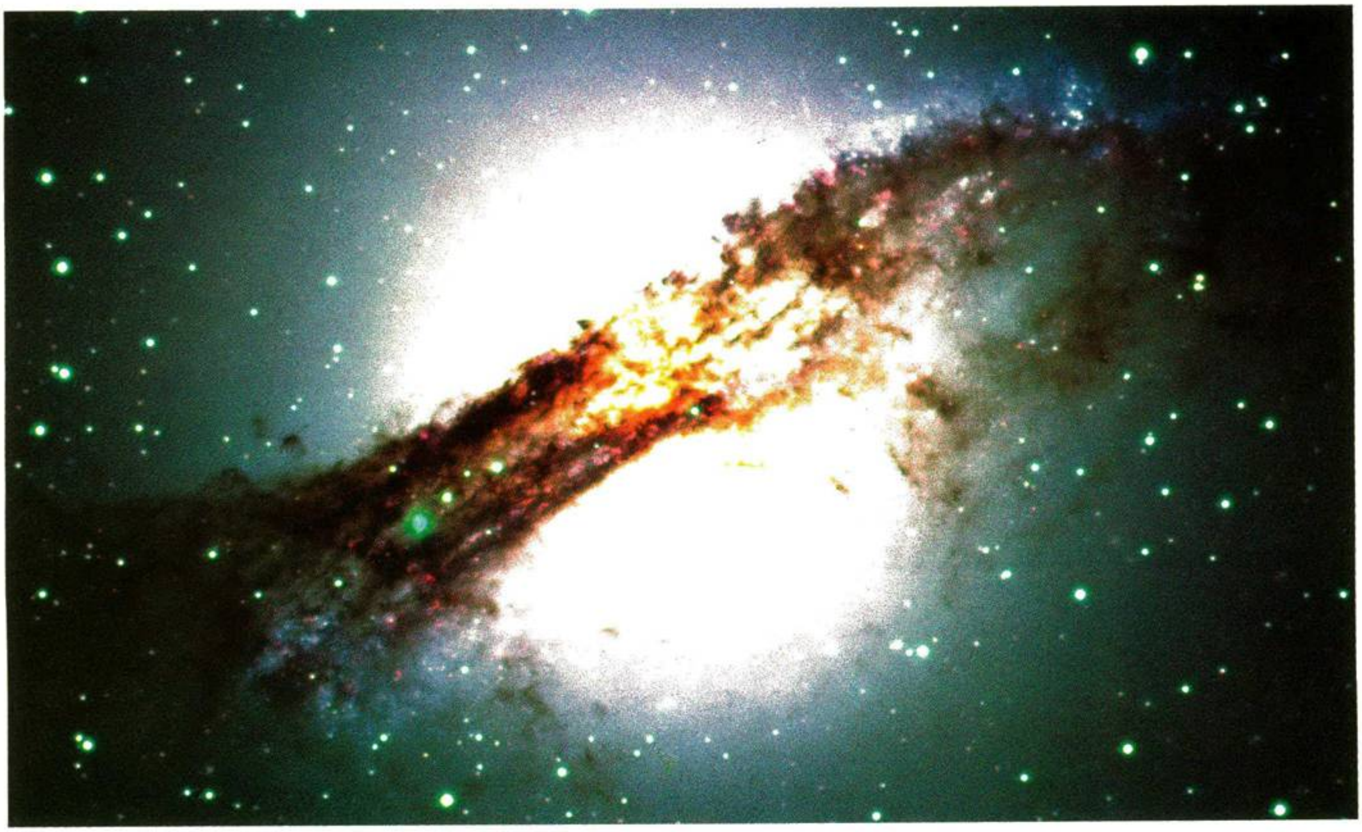
Visible in the Hubble Deep Fields North and South were galaxies among the earliest yet imaged. Astronomer Harry Ferguson of the Space Telescope Science Institute (STScI) notes that the recent "white light" image of the HDF South provides the deepest, highest-resolution view yet of the early universe. If the whole sky could be imaged to that depth, Ferguson estimates that it would contain as many as 125 billion galaxies. Many of the galaxies are difficult to resolve, even with HST. "The angular sizes of these galaxies are so small that the physical sizes must be less than about 3,000 light-years," says Ferguson. (The Milky Way is roughly 100,000 light-years in diameter.) "Do these high-redshift dwarfs fade to become dwarf spheroidal galaxies in more recent times? Or do they merge into bigger objects? Even though they are faint, they are brighter than we expected if they become nearby dwarfs."

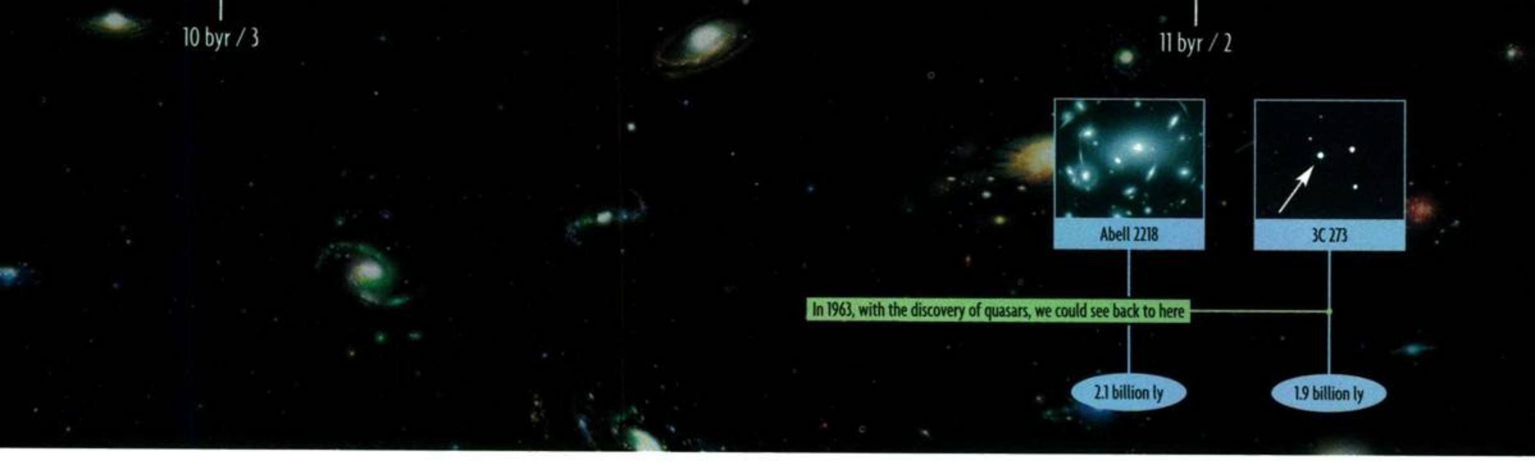
Elliptical galaxies, the major components of spiral galaxies, and vast populations of dwarf galaxies are ancient. Are any galaxies young? Some are, such as Leo A, a nearby dwarf galaxy, which is only about two billion years old, according to astronomer Eline Tolstoy. However, some are "Hollywood galaxies" that merely look young. "It's hard to tell which is which," says Ferguson.

For example, an ancient galaxy undergoing a recent burst of star formation would appear to be young, but it would have more red stars than a truly young galaxy. "But dust in a young galaxy can make it appear redder. So it's a tough one," says Ferguson.

A galaxy would seem to be old if it has had time to relax symmetrically from its initial lumpy, diffuse state. Similarly,

The odd galaxy Centaurus A formed from the head-on collision of two galaxies about a billion years ago, creating the elliptical dust band.




10 byr / 3
11 byr / 2
Abell 2218
3C 273
In 1963, with the discovery of quasars, we could see back to here
2.1 billion ly
1.9 billion ly

Left to right: Abell 2218: HST/STScI; 3C 273: DSS; Abell 98: WIYN; NGC 6240: William Keel, University of Alabama; Corona Borealis galaxy cluster: DAO; Stephan's Quintet: William Keel, University of Alabama; Coma Cluster: William Keel, University of Alabama; M100: David Malin/Anglo-Australian Telescope Board; M83: William Keel, University of Alabama; M31: Astronomical Institutes, Bonn

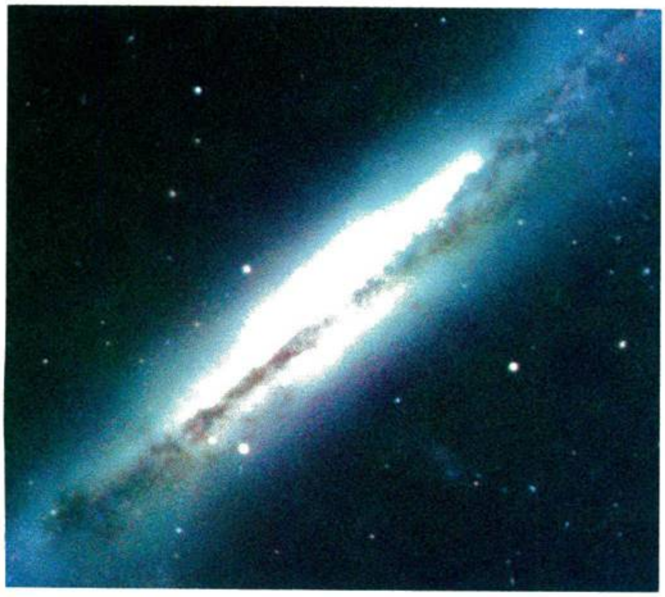
galaxies that have had time to mint heavier and heavier atoms in successive generations of stars would be considered old.

"We can do two things to see if a galaxy is really young," says Kormendy. "In the infrared, we can see if there's a population of old stars in addition to the starburst going on. We can also check metallicities: Seeing a galaxy, such as I Zwicky 18, with a low metal abundance in its gas implies that it has not formed many stars in the past."

Knowing that heavier and heavier metals are made following bursts of star formation, astronomers are trying to decipher the life histories of young and old galaxies. "Figuring out the dynamics strains even HST's imaging capability," says Keel. "On the chemical question, astronomers will take a leap with the new generation of large ground-based scopes such as the VLT and Gemini, which by both infrared spectroscopy and detecting redshifted spectral features will help track changes in cosmic chemistry."

Mauro Giavalisco of STScI locates ancient, star-forming galaxies by looking for the spectral signatures of young, massive stars where the universe was 10 to 15 percent of its current age. He then studies their morphologies in detail using HST. Detecting these primeval galaxies has given astronomers a population of objects that presumably contain some of the earliest known stars. Giavalisco and his colleagues have not yet measured how old those stars are. But they must be older than 12 billion years. Not all of them are still visible: The most massive ones burned out after a few million years. The less massive ones should still be shining. Where are they? "Curiously, we find that these galaxies contribute from 35 to 50 percent of the present-day stars in the universe," says Giavalisco. "That's a lot of stars. Because they are among the oldest stars today, they ought to reside in bulges, ellipticals, and lenticulars." But whether Giavalisco's galaxies are subgalaxy fragments that later merged or whether they evolved in some other way into the present galaxy shapes is still open to question.

Spiral galaxies such as Leo's NGC 3628 are mostly absent from the early universe. They formed from the mergers of dozens of fragments.

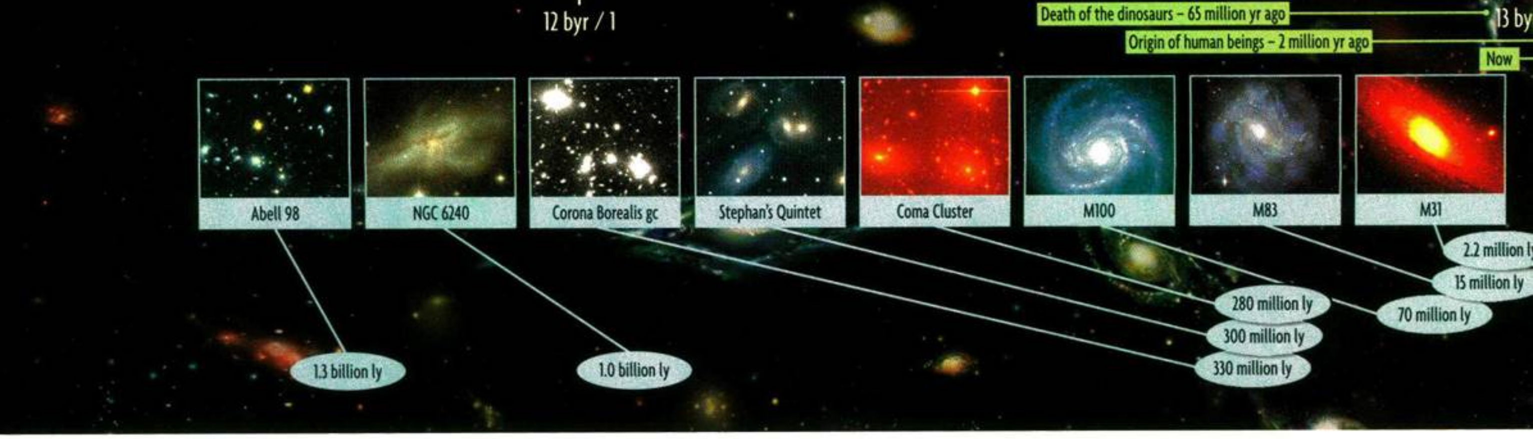


Even relatively simple questions astronomers thought they knew the answers to 20 years ago, such as, "Are disks older than bulges?" and "Are ellipticals old?", seem controversial if observers look at the right galaxies. Roberto Abraham of the Institute of Astronomy in Cambridge, England, suggests that by coupling high-resolution imaging by HST and redshift surveys, it's clear that if you look back halfway to the beginning of time, to a redshift of 1, about one-third of galaxies are spectacularly weird compared with the normal Hubble classification system (see "Pinning Down Galactic Forms," p. 43). "While it's possible that many of these odd systems are mergers," says Abraham, "there also seem to be classes of objects that we don't see in the local universe." Abraham suggests that among the latter are odd chains of galaxies such as those observed by Len Cowie of the University of Hawaii, which may be protogalaxies forming in a massive, linear chain reaction of starbursts. "You can also see a lot that's missing in the earlier universe," says Abraham, "such as strongly barred spirals — they're rare at redshifts greater than 0.5."

Many astronomers also believe that the central bulges in spiral galaxies are older than the galaxies' disks. Disks rotate because protogalaxies, very early on, were slowly spinning. The gas that forms disks collapses into these slowly spinning dark halos, and the rate of the spin of the gas increases. The bulge and the outer halo of the Milky Way have the oldest stars. However, simulation models show that a bar naturally forms along with the disk, becomes unstable, and buckles and puffs up to form a bulge. Which comes first — the disk or the bulge? "My money is on the bulges as the oldest parts of galaxies," says Abraham. "They're generally redder than disks even at high redshifts, and bars seem rare at high redshifts."

Big Eyes Ahead

Many avenues of research lie ahead for extragalactic astronomers. Certainly much will be learned with the Next Generation Space Telescope (NGST), the replacement for HST that will go on line about 2008. NGST will be an 8-



meter-class telescope and will penetrate extremely deeply into the universe.

However, NGST won't provide sharper views in the infrared than HST. It will offer tantalizing views of what's out there near the edge, "but it will run out of light," says Gallagher. The VLT, with spectroscopy, will have the capability to go as deep or deeper than NGST. Though it will show extremely distant objects, NGST may or may not solve questions of historic proportion. Opinions vary.

Will NGST see the first galaxies? Most astronomers consider that question flawed. They say the question should be: Will it see the processes that created galaxies? "The first galaxies were so rare that a single telescope with a narrow field of view will have little chance of seeing them," says Silk. "But it should distinguish whether galaxies formed from mergers of many small subunits or monolithically."

"NGST should see the first galaxies," Ferguson believes. "But even if it finds some at very high redshifts, I'm not sure we will ever know if they were the first ones."

NGST will not act alone, however. Another powerful project, the Sloan Digital Sky Survey (see "Stars and Strips Forever," February issue), uses a relatively small telescope to survey a huge swath of the sky. It will not go extraordinarily faint, like NGST. By giving astronomers a refined, three-dimensional map of the sky, Sloan will discern when the first quasars formed, how the Milky Way formed, and help answer cosmological questions about the nature of dark matter. "Sloan should nail down our understanding of large-scale structure," says Kormendy. "It's suspicious that the largest scale things we see, voids and superclusters, are almost always as large as the survey volume. This suggests that maybe we haven't found the largest things that exist out there yet." Sloan and NGST together will make a powerful combination. "Imagine the harvest of the Hubble Deep Fields many times over," says Keel.

Large ground-based telescopes, both optical and submillimeter, may also beat NGST to the punch in answering some of astronomy's biggest questions. So might cosmic microwave background satellites that will orbit sooner, such as NASA's Microwave Anisotropy Probe (MAP) and the European Space Agency's Planck mission. "By the time NGST flies we will already know the gross history of star formation and will have samples of galaxies out to a redshift of 7," says Cowie. "The process of galaxy formation, when and where the spheroids and disks were assembled, and which wavelengths hold the light from the first star formation will be broadly understood." The large ground-based scopes will certainly enhance NGST's data with deep, narrow fields being imaged from space and corresponding spectroscopy being taken from the ground. That's what's happening now with HST and Keck. NGST will do the same with the largest spectroscopic telescopes on Earth. Indeed, a number of groups, including European and American astronomers, are in the early stages of discussing 30-meter or 50-meter telescope projects designed for just this purpose.

U.S. Naval Observatory

One of the few genuinely young galaxies known, Leo A is a wisp of gas that 2 billion years ago triggered a wave of starbirth.

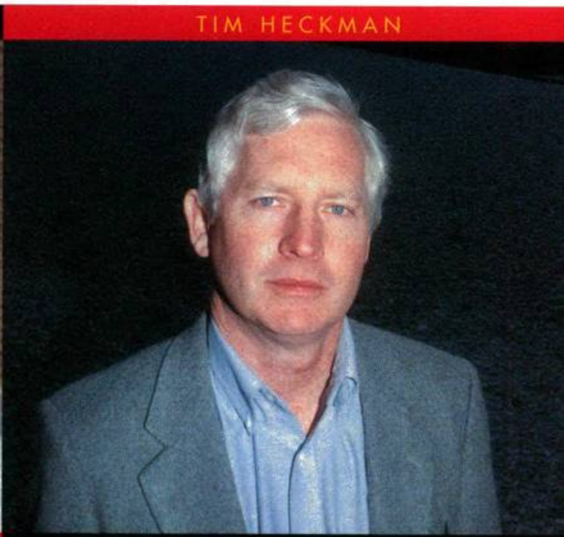
Whatever routes astronomers take to solve galactic mysteries, we are living at an exciting time, standing on the precipice of signal discoveries. We may see the processes that formed the first galaxies and therefore understand how they evolved over the ages. We also may see the first generations of stars and nail down the parameters that describe the universe as a whole, such as its age and fate. The story of galaxies will, over the next decade or two, become more meaningful. Unexpected delights will certainly arrive. "I think Francis Bacon said that 'There is no excellent beauty that hath not some strangeness in the proportion,' " Kormendy reflects. "Galaxies are both symmetric enough and strange enough to please us. They cry out to be understood." In the end, what drives the toil for extragalactic astronomers is pretty simple. Why study them? "We live in one," says Impey. "I want to understand my home." ■

David J. Eicher, Astronomy's *managing editor, has been observing and thinking about galaxies for 21 years.*

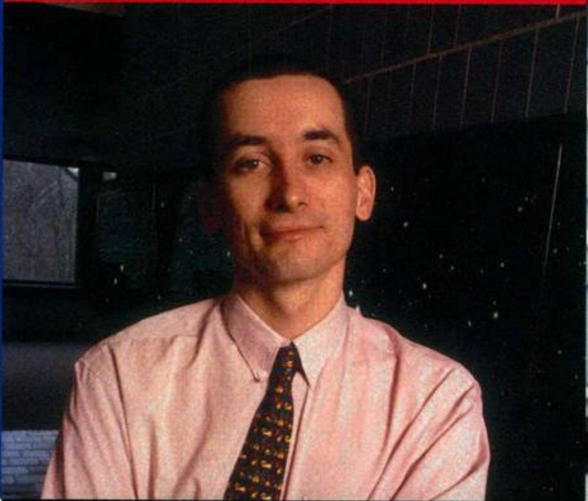
BLACK HOLE

LINDA DRESSEL

TIM HECKMAN



ROELAND VAN DER MAREL



MEG URRY

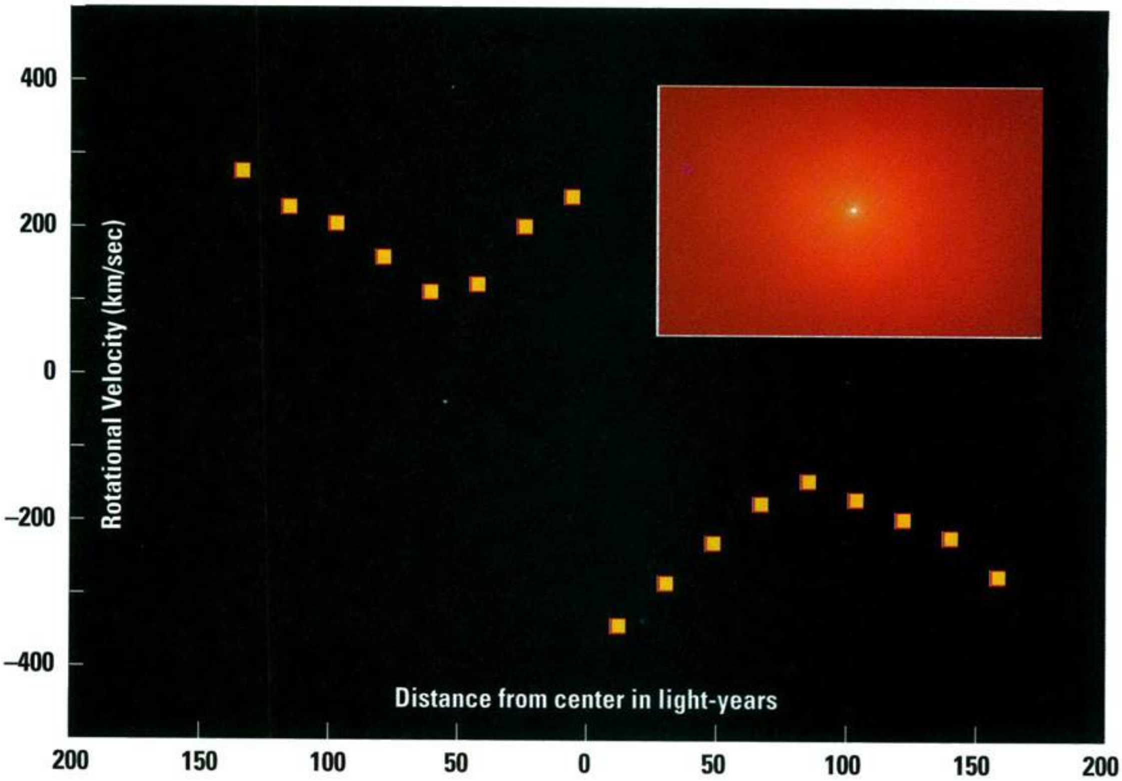
All portrait photos: Laura Miller

Four astronomers seek to understand monster black holes in the centers of galaxies. by Steve Olson

The biologist Lewis Thomas once compared science to a beehive. "There is nothing to touch the spectacle," he wrote. "In a kind of activity that seems as random and agitated as that of bees in a disturbed part of the hive, there suddenly emerges, with the purity of a slow phrase of music, a single new piece of truth about nature."

When it comes to studying black holes in the cores of galaxies, the biggest and busiest beehive on the planet perches on the edge of a woody ravine in Baltimore, Maryland. Each year hundreds of astronomers come to the Space Telescope Science Institute (STScI), the nerve center of the Hubble Space Telescope, to peer into the tortured hearts of galaxies.

HUNTERS



Gas near the center of the galaxy NGC 3998 whips around at hundreds of kilometers per second, betraying the presence of a massive black hole. Studies of other large galaxies show that almost all possess huge black holes at their centers.

Astronomy: Elisabeth Rowan, after Linda Dressel; inset: Linda Dressel (STScI), et al., and NASA

Black hole hunters are studying the most exotic things in the universe — objects that pack the mass of millions or billions of suns into a volume no larger than our solar system, where space curves back on itself and time stands still. Once considered a theorist's fancy, black holes are now thought to reside at the core of almost all large galaxies. Yet they remain elusive, their interiors forever shrouded behind a gravitational attraction from which not even light can escape.

The scientists who study black holes in galaxies rarely think of their work in such rarefied terms. Each is trying to solve a specific problem. Only when they pause to look at the big picture does a note of wonder creep into their voices. This is a story about four of those researchers. Three are resident scientists at STScI and the other works across the street at Johns Hopkins University's Center for Astrophysics. Each has different interests and different ways of doing science. Yet together they are trying to understand the most extreme environments in the cosmos.

SEEING TO THE CENTER

Astronomers have been seeing black holes — or at least the consequences of black holes — for decades. But for a while they had no idea what the strange objects were.

One such object appeared as a signal in the radio telescope of Grote Reber, an eccentric bachelor and ham radio operator in Wheaton, Illinois. In the 1930s, Reber built a 30-foot radio telescope in his mother's backyard with which he mapped radio emissions from the sky. He discovered two unusually strong radio beacons — one in the center of the Milky Way Galaxy and one in the constellation Cygnus. What could be generating such strong signals?

Mt. Wilson astronomer Carl Seyfert produced the next exhibit in the cosmic bestiary. In 1943 he published a list of galaxies, now known as Seyfert galaxies, that shine much more brightly in their cores than do normal galaxies and seem to contain gas moving at several percent the speed of light.

Then, in the early 1960s, the strangest objects of all turned up. These objects looked like stars, but they were powerful radio emitters with strange visible light spectra. After studying one such object, Maarten Schmidt at the California Institute of Technology realized that the odd spectrum was due to the object's light being stretched, or redshifted — a sign that it was receding rapidly from Earth as the universe expanded and therefore lay 2 billion light-years away. This quasi-stellar object, or quasar, was producing 100 times as much light as the brightest known galaxy, but the energy was pouring out from a volume smaller than that of the solar system.

As early as 1964, Edwin Salpeter, an astrophysicist at Cornell University, and Yakov B. Zel'dovich, the leader of an atomic bomb design team in the Soviet Union, independently proposed that quasars and similar oddballs might be galaxies powered by massive black holes in their cores. But how could one prove it? After all, black holes are black — they don't show up on photographic emulsion.

One clue, astronomers realized, is the motion of stars in the central parts of galaxies. If a galaxy does not contain a large mass at its center, stars close to the center should move more slowly, just as the central parts of a phonograph record travel more slowly than those on the edge. But if a galaxy harbors a massive black hole, the opposite should occur. Stars close to the black hole would have to whip around it at immense speeds to keep from falling into its gravitational maw.

During the 1980s and early 1990s, ground-based telescopes hinted at this frenzied activity in the centers of galaxies. But their resolution wasn't good enough to prove that monster black holes were responsible for this activity.

The Hubble Space Telescope promised to be a dream come true for black hole hunters. With Hubble's superior resolution, astronomers could extend the black hole search to far greater distances encompassing hundreds of thousands of galaxies. After astronauts installed corrective optics on Hubble in December 1993, several teams got to work.

Linda Dressel was a member of one of these teams. At Johns Hopkins University, astronomer Holland Ford had put together a group to study M87, a giant elliptical galaxy in Virgo about 50 million light-years away. M87's core emits an immense jet of particles traveling at near light speed, a sure sign that something bizarre is going on. Dressel was one of the team members who analyzed images and spectra of glowing gas very near the galaxy's center. If M87's core contained a black hole, Ford's team reckoned, the gas on either side should be moving rapidly in opposite directions.

On May 6, 1994, the team met at STScI to go over the observations. A team member passed out the data from Hubble's Faint Object Spectrograph (FOS), and everyone did a quick calculation of velocities. The gas appeared to be whirling around the core at 1.1 million miles an hour (500 kilometers a second). To accelerate gas to that extreme speed, M87 must contain a central black hole with about 2 billion solar masses. "It was hard not to cheer and bounce off the walls," Dressel recalls. "It was fun."

Today, Dressel (who left Johns Hopkins in late 1998 to take a job at STScI) is in charge of a Hubble project to look for supermassive black holes in a dozen other galaxies. She takes spectra of galactic cores with the Space Telescope Imaging Spectrograph (STIS), which was installed in February 1997 to replace both the FOS and another spectrograph. FOS could take only one spectrum at a time. But STIS peers through a long slit, enabling astronomers to take more than a dozen spectra simultaneously. "The FOS was a difficult instrument to use," says Dressel. "But on the first galaxy I looked at with STIS, NGC 3998, I got about 20 spectra all at one go, instead of painfully doing it one by one with FOS."

Dressel's STIS observations showed gas swirling around the center of NGC 3998 at 900,000 miles an hour (400 kilometers a second), implying a central black hole with 100 million to 200 million times the mass of the sun. Several galaxies Dressel has since studied have central black holes on the order of 100 million solar masses. "People used to ask if a particular galaxy had a black hole. Now we're starting to wonder whether any galaxy does *not* have a black hole," she says.

Ultimately, Dressel would like to relate the masses of these black holes to other properties of the galaxies, such as their types, luminosities, central stellar densities, and extent of nuclear activity. "We need a lot more observations of nuclear black holes so we can see if there are patterns," she says.

ADOLESCENT BLACK HOLES

Essentially, Dressel is extending the study of black holes from individuals to societies. Or as Roeland van der Marel of STScI puts it, "The

LINDA DRESSEL

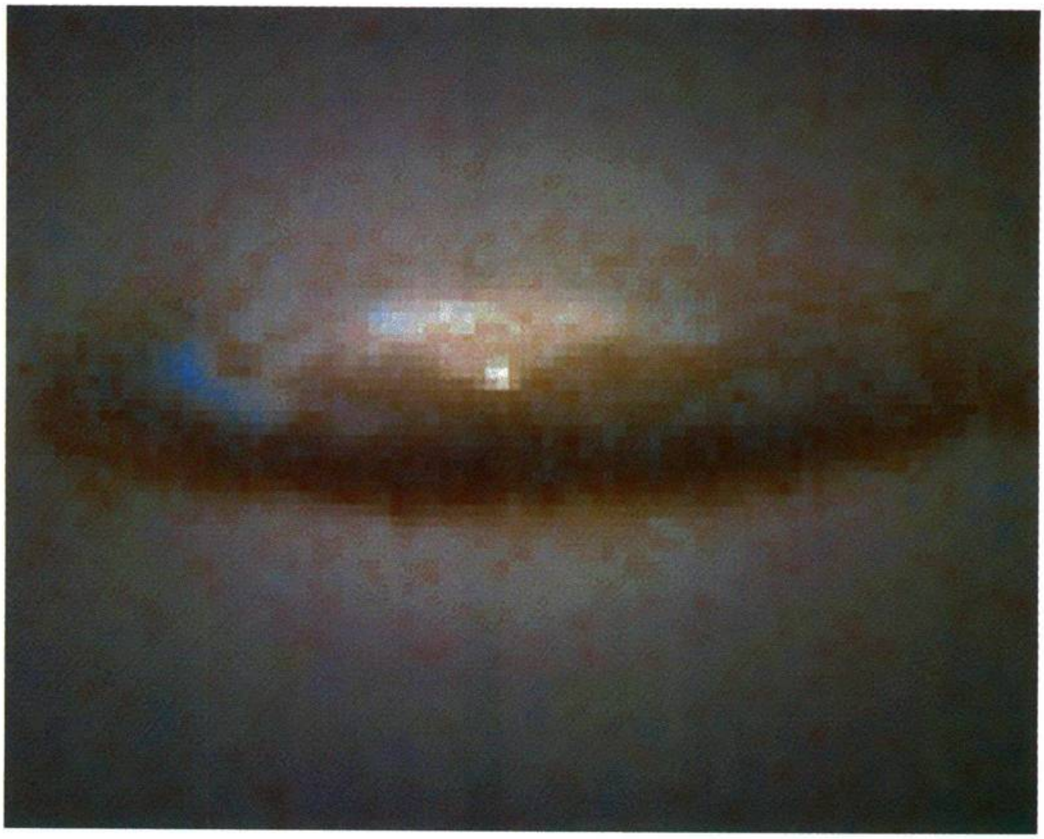
"I was in the sixth grade when Alan Shepard went into space, and after that I learned everything I could about NASA," says Linda Dressel, who grew up in Cincinnati, Ohio. "At first I thought I wanted to be a NASA engineer, but then I started learning about physics and astronomy."

Upon entering the University of Cincinnati, Dressel was faced with the choice of being one of the few women in engineering classes of hundreds or the only woman in physics classes of ten. More confident of her abilities in physics, Dressel chose the latter. "I didn't really need role models," she says, "and there weren't any anyway."

Her interest in astronomy jelled the summer after she graduated from college. "I was a National Radio Astronomy Observatory summer student, and I got sent to the Kitt Peak branch in Tucson," she says. "That was the first time I ever looked through a big telescope. I still remember looking at the Trifid Nebula. The dust lanes were so black you felt like you were falling into them."

After earning her Ph.D. in astronomy from the University of Virginia in Charlottesville, Dressel conducted research at the University of Maryland, NASA's Goddard Space Flight Center, Rice University, and Vanderbilt University. But she often found herself the only person studying active galaxies in departments focused mainly on stars and normal galaxies. Then, in 1990, she began working with one of the research teams using the Hubble Space Telescope to look for supermassive black holes in the cores of galaxies.

Still, old habits die hard. The recent recipient of a five-year grant from NASA to continue the search for black holes in nearby galaxies, Dressel intends to do most of the work herself. "I like to work independently," she says.



The galaxy NGC 7052 sports a dust disk 3,700 light-years across that rotates like a carousel around a black hole weighing 300 million suns (hidden in the core by densely packed stars). R. van der Marel (STScI), et al., and NASA

question has changed from whether we can find a black hole to what are the properties of the black hole population."

Van der Marel takes a somewhat different approach to the study of black holes in galactic cores. A theoretically oriented astronomer who also maintains a busy observing schedule, he sees observations as a way of piecing together a much larger story. "I like to do the whole thing," he says, "from making the observations to making models of what I see."

A native of the Netherlands, van der Marel wrote his Ph.D. dissertation on the motions of stars in the centers of galaxies. Sitting at his computer terminal, he still can call up a video showing how stars should move in galaxies with and without a central black hole.

These days he's thinking more about how black holes got into the centers of galaxies. The basic idea hasn't changed much since the early 1960s. It proposes that galaxies and their central black holes somehow formed together early in the history of the universe. The black holes then began to grow by swallowing huge amounts of galactic gas, dust, and entire stars. As matter swirled into each cosmic Charybdis, friction heated it up and caused it to radiate brightly across the spectrum. The result was a quasar, outshining all of the stars in the surrounding galaxy combined.

But if all large galaxies contain monster black holes in their cores, why aren't all cores luminous? Apparently, not all the black holes are still eating. Some nearby galaxies, such as

ROELAND VAN DER MAREL

"The only telescopes I've ever observed with have been the 4-meter Herschel Telescope on the Canary Islands, the 10-meter Keck in Hawaii, and the Hubble Space Telescope," says Roeland van der Marel of the Space Telescope Science Institute. "I skipped the smaller ones. I've been lucky that way."

Van der Marel's career has been as charmed as his observing history. He came to the United States in 1994 when he was awarded a prestigious Hubble Fellowship to use the Space Telescope to study black holes in the centers of galaxies (in his office, a copy of *Immigration Procedures Handbook* sits next to *Table of Integrals, Series, and Products*). He did his fellowship at the Institute for Advanced Study in Princeton, New Jersey, before moving to STScI in 1997 to continue his work on black holes (summarized on his home page at http://sol.stsci.edu/~marel/home.html).

Growing up near the Hague, van der Marel learned to play chess before he learned to read. He studied both astronomy and mathematics at nearby Leiden University, a traditional astronomy powerhouse.

Astronomy won out in the end. "In mathematics all you need is a desk. But astronomy has so much more: state-of-the-art instruments, observing in exotic places, collaborating with people all over the world. It was the interaction of big instruments and pure thought that drew me to astronomy, and I haven't regretted it since."

M87, remain active, but they don't hold a candle to their former selves. Almost all the quasars we see are billions of light-years away — and thus we see them as they existed billions of years ago. "The typical idea is that the quasar turned off," says van der Marel. "Maybe it doesn't have enough fuel to be a quasar anymore. Or maybe it is still accreting matter but without spewing energy out."

Even though most black holes seem to have turned into fat, placid adults, some still kick up their heels. Galaxies such as M87 and Seyfert galaxies generate plenty of energy in their cores. And even relatively quiet black holes, such as the one lurking in the core of the Milky Way, could flare if a passing star or dust cloud strays too near.

Most recently, van der Marel has been examining an intriguing relationship between black holes and their host galaxies. Based on the examples known today, the mass of a galaxy's black hole seems to vary in direct proportion to the mass of a galaxy's central bulge: the more massive the bulge, the more massive the black hole. "We don't know for sure why that is yet," says van der Marel.

ONE OUT OF MANY

The picture that emerges from van der Marel's work is one of remarkable uniformity. Almost all large galaxies seem to have central black holes, and many may have gone through a quasar phase. So why do active galaxies look so different?

The galactic menagerie today includes objects just as wild as quasars. Some galaxies, such as M87, shoot gigantic jets into intergalactic space. Some are powerful radio beacons. Even Seyfert galaxies (and quasars) have been divided into two categories. And a few dozen galaxies seem to have particularly severe hyperactivity problems. They radiate brightly at almost all wavelengths, from low-energy radio waves to high-energy gamma rays, and they can vary in brightness on timescales of minutes. Known as blazars (some blazars are also called BL Lacertae objects after their prototype example), they can shine 10 to 100 times as brightly as quasars at comparable distances.

Observational and theoretical research by Meg Urry of STScI has helped show that much of this variety is illusory — all active galaxies are powered by supermassive black holes. "To the first order we think all active galactic nuclei are the same in terms of their structure," she says. "What we see depends on our viewing angle."

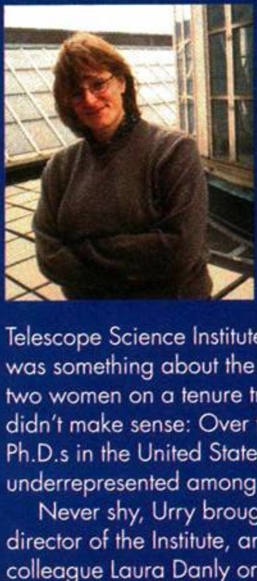
Consider blazars, for example. No known source of energy could shine so brightly in all directions. So Urry and other astronomers have concluded that blazars are essentially galactic ray guns aimed directly at Earth; we are looking right down the barrel of a galactic jet like the one shooting out of the core of M87. "It's magnified a million times from what you see if you're looking at it from the side," says Urry.

The orientation issue is so important that Urry and other astronomers consider its effects with other active galaxies. For example, Hubble has taken spectacular photographs of doughnut-shaped dust clouds around the centers of galaxies. Urry and other astronomers believe that galaxies look different depending on whether we see their central black holes directly or through this veil of dust. The mass and spin of a black hole or the size of the black hole's disk of accreting matter might also affect a galaxy's appearance.

But Urry believes that the basic physical mechanisms in all active galaxies may be the same. "There are still some problems that need to be resolved, and many intrinsic physical differences need to be worked out," she says, "but these are far from falsifying the concept of unification."

Urry is currently using Hubble to observe more than 100 BL Lacertae objects. Her team is comparing the properties of their host

MEG URRY



"I was a latecomer to astronomy," says Meg Urry. "Many of my colleagues grew up knowing they wanted to be astronomers. But I didn't at all. I liked science in college, but I liked English, mathematics, and history, too." A challenging physics class finally made Urry decide on a major: "I said to myself, 'I want to figure this out.'"

After getting her Ph.D. at Johns Hopkins University, Urry was a postdoc at the Massachusetts Institute of Technology and the Space Telescope Science Institute, which led to a full-time job in 1990. But there was something about the Institute that bothered her: She was one of only two women on a tenure track staff of more than 50 Ph.D. scientists. It didn't make sense: Over the previous century, 10 percent of astronomy Ph.D.s in the United States had gone to women. Why were women so underrepresented among senior astronomers in the United States?

Never shy, Urry brought her concerns to Riccardo Giacconi, then director of the Institute, and found a receptive ear. In 1992 she and her colleague Laura Danly organized a meeting at the Institute of 200 astronomers, mostly women. Together they produced a document called the Baltimore Charter, which states in part, "Women want and deserve the same opportunity as their male colleagues to achieve excellence in astronomy." Equal opportunity "does not involve lowering standards," says Urry. "It requires less reliance on networks and more reliance on objective measures to make decisions."

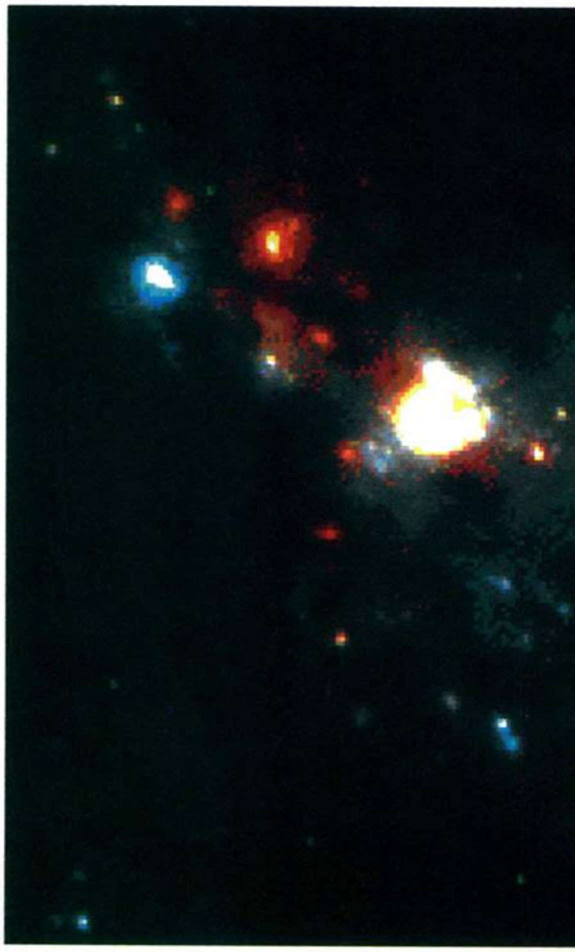
Today the 30 tenured astronomers at the Institute include three women, and five more are on the tenure track. "To the best of my knowledge we now have more women at the Institute than in any other astronomy department in the country," Urry says.

galaxies to those of radio galaxies. "They match very nicely," she says, "so once again it supports unification."

BURSTING WITH STARS

Unification is also a powerful theme in the work of Tim Heckman of Johns Hopkins University. Heckman studies starburst galaxies — cosmic conflagrations in which millions of massive, newborn, bright stars suddenly flare near a galaxy's center. Starbursts usually occur when neighboring galaxies come close enough together to send huge amounts of gas and dust into the central regions of one or both galaxies. They emit their own distinctive ultraviolet-light signature, enabling astronomers to spot them throughout the universe.

They also can be extremely powerful: Some starbursts, though powered only by starlight, shine almost as brightly as quasars. In fact, starbursts may account for some of the activity commonly attributed to black holes. "Black holes certainly do some of the things we see," says Heckman, "but not everything."



Right: A powerful starburst triggered by the collision of two galaxies lights up Arp 299. Dust shrouds much of the starburst, which produces 30 times as much energy as the entire Milky Way Galaxy.

Gerhardt Meurer and Tim Heckman (Johns Hopkins University) and NASA

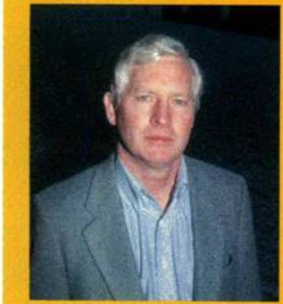
But which energy source — feeding black holes or starbursts — dominates a particular galactic core? Using Hubble and ground-based telescopes, Heckman's group has found the spectral signature of huge ensembles of hot newborn stars encircling the cores of active galaxies. "After correcting for the fact that dust absorbs most of the ultraviolet light from the starburst, we find that the starburst is producing roughly half of all the energy that's coming from the nucleus," says Heckman. "The other half might be coming from the black hole."

Despite this finding, the exact relationship between black holes and starbursts remains unclear. Not all galaxies with supermassive black holes are undergoing starbursts, and not every starburst galaxy necessarily has a feeding black hole. Could the black hole somehow trigger a starburst? Or could a starburst play a role in feeding material to the black hole, enabling it to grow even larger? "It's a very murky picture right now," says Heckman. "We're struggling to establish whether or not starbursts are a necessary part of the active galaxy phenomenon."

SOLVING THE PUZZLE

The apparent connection seen between starbursts and black hole feeding, the preponderance of quasars in the early universe when massive galaxies were being assembled, and the linear relationship between the mass of a black hole and the mass of the surrounding galactic bulge all suggest that the evolution of galaxies and the evolution of black holes are intimately related. But how?

TIM HECKMAN

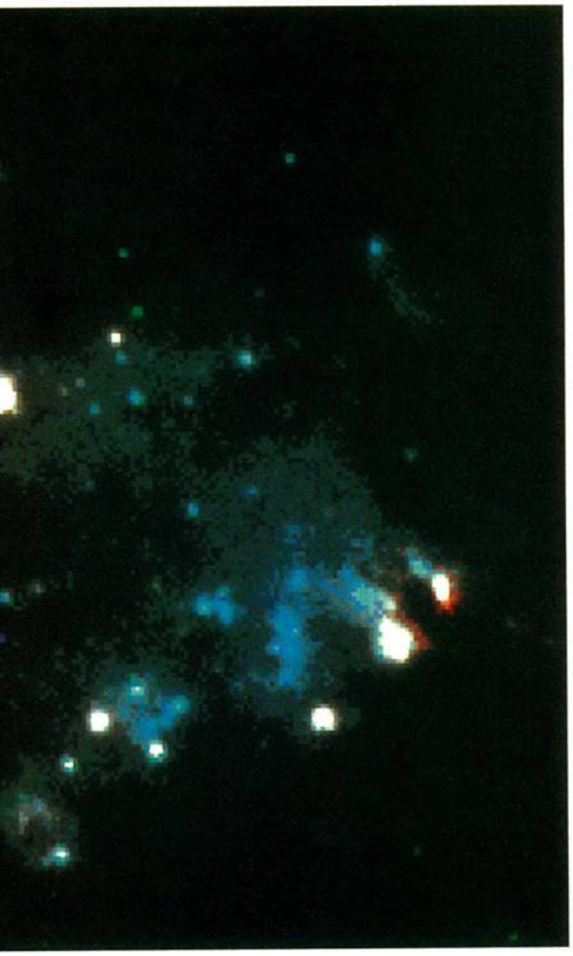


"You have to do astronomy because you're obsessed with it," says Tim Heckman of Johns Hopkins University. "That's what carries you through the hard times."

For Heckman, the obsession hit early. Growing up in Toledo, Ohio, he knew he wanted to be an astronomer after reading a book about the moon given to him by his father. But even with an undergraduate degree from Harvard, jobs were not easy to find. The early 1970s were hard times for young scientists, with many parallels to today's depressed astronomy job market. "When I was admitted to graduate school at the University of Washington, the astronomy department wrote us a letter that said getting a job would be hopeless. 'You should be doing this because you love astronomy,' they told us. And I still stress that to my graduate students."

With his Ph.D. in hand, Heckman went to the Netherlands and to the University of Arizona as a postdoc. He then landed a faculty position at the University of Maryland, which brought him closer to Johns Hopkins, where he was hired when the physics and astronomy department beefed up its staff to take advantage of the nearby Space Telescope Science Institute.

Heckman believes that the tough times for young scientists may be about to ease, just as they did when he got out of graduate school. "There's a groundswell of support for science and technology right now in Congress," he says. "And astronomy plays an important role in this because almost everyone is interested in astronomy."



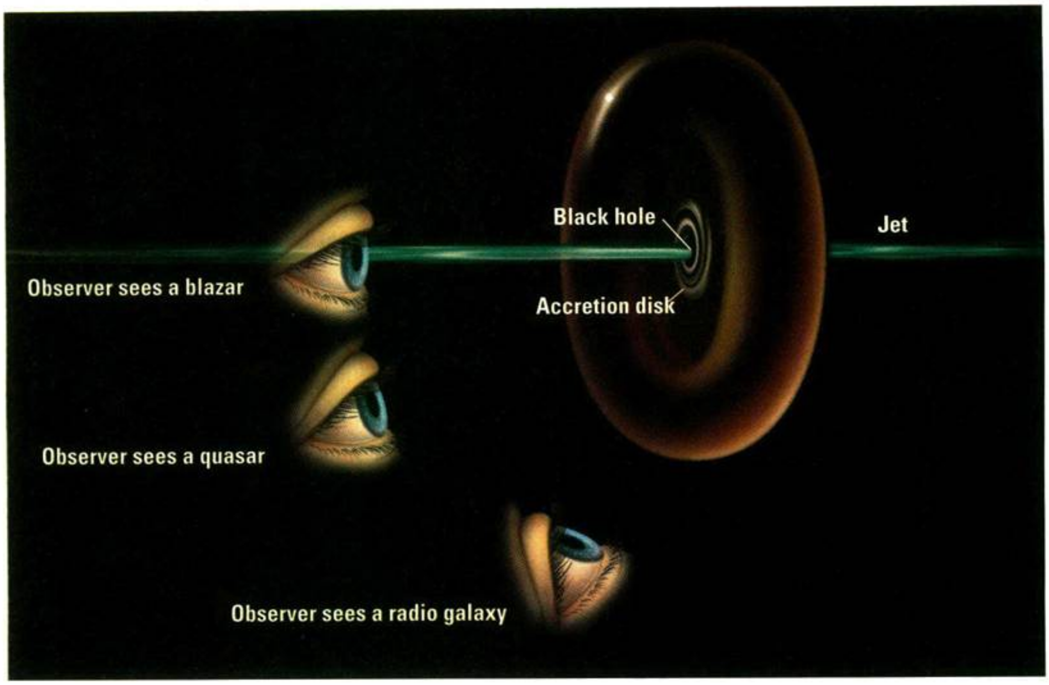
"That's the $64,000 question," says Heckman. "What is the connection between quasars, which correspond to the building of black holes, and the formation of different components of the galaxies? We'd like to understand what that relationship is."

Theorists are starting to come up with ideas, says Douglas Richstone of the University of Michigan. For example, the orbits of objects in developing galaxies might force a portion of the mass to coagulate in the center as a black hole. Or smaller black holes might merge into central monsters. "All of the theories are plausible," says Richstone, "but if you go to a doctor and he says that you have diseases *x*, *y*, and *z*, you might want to get a second opinion, because you're unlikely to have all three."

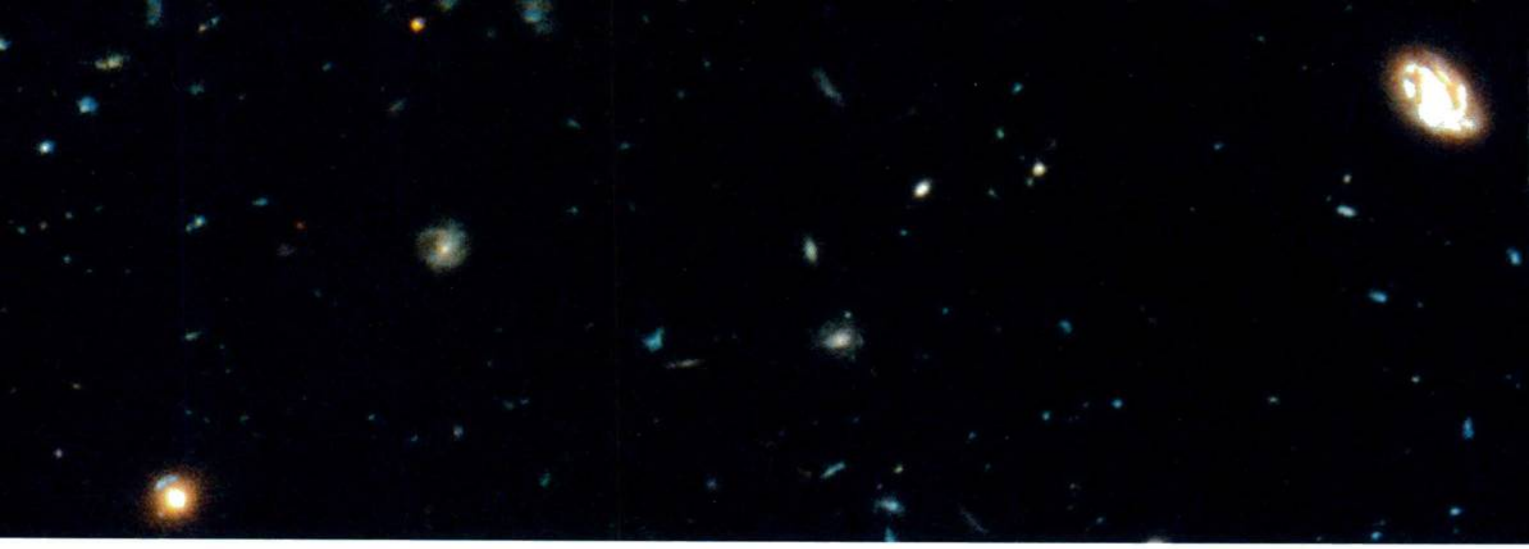
Future observations, both from the ground and from space, will be critical. In the next decade NASA plans to launch the Space Infrared Telescope Facility, or SIRTF, and Hubble's much more powerful successor, the Next Generation Space Telescope. These telescopes will be able to look back almost to the beginning of time to see galaxies forming. By examining the relationship between quasars and their host galaxies and by comparing the host galaxies to normal galaxies of the same age, astronomers should be able to pin down the role of black holes in galaxy formation.

Astronomers typically have assumed that galaxy formation is a complicated process. Galaxies seem too varied to have simple and uniform origins. But the presence of black holes in galaxies is giving astronomers hope that the story may be simpler than they thought. It would be a rich irony if the most mysterious objects in the universe help solve one of its greatest puzzles. ■

Steve Olson is a science writer in Washington, D.C. His previous feature article for Astronomy *was "Raising Astronomers" (December 1997).*



Astronomers are beginning to believe that a relatively simple model can explain a wide variety of active galaxies. If we happen to look down the barrel of a galactic jet, we see a blazar, while viewing a little off to the side produces a quasar and a steep angle gives rise to a radio galaxy. *Astronomy*: Elisabeth Rowan



A Googolplex

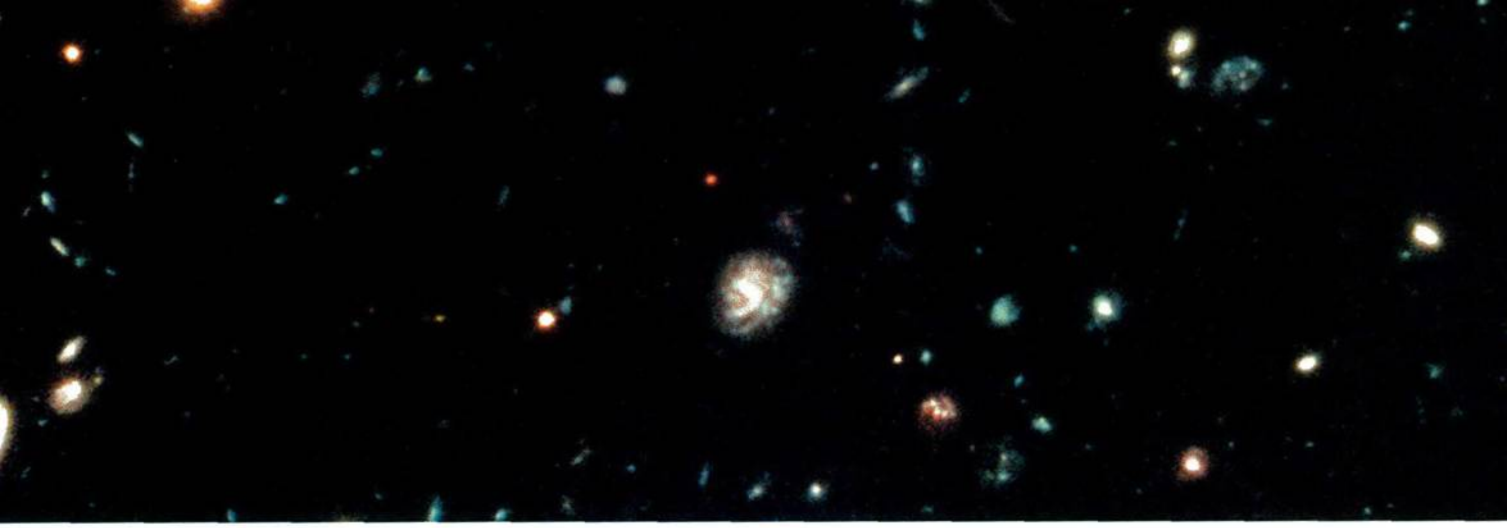
"Not everything that can be counted counts, and not everything that counts can be counted." — *Albert Einstein*

The trouble with galaxies is that, in the end, they are incomprehensible. The word "galaxy" is part of everyone's vocabulary, and if asked to define it by, say, a sixth grader, those who read *Astronomy* could give a pretty satisfactory answer. We know about spirals and ellipticals, about colliding galaxies and Halton Arp's peculiar galaxies. As far as real comprehension goes, however, it is like saying we know how much a billion is, or a trillion. We can rattle off the standard definition, but we don't have any intuitive feel for how long it would take to count to a billion if we counted at the rate of one number per second, 24 hours a day. (It would take 31 years.) Well, billions are the smallest numbers it makes sense to use when talking about galaxies.

Anyone who has seen 100,000 snow geese take off at the same time at the Bombay Hook National Wildlife Refuge in Delaware knows she has seen a large number of white birds fill the sky. But that's 10,000 times less than a billion. When Chris Mihos at Case Western Reserve is making movies of galactic collisions, he uses a lot of white dots. The dots are not individual stars; each dot represents 100,000 stars.

You tell me that there are 100 billion in our galaxy alone. I nod assent. Do I really get it? Suppose you were a one-celled animal living in the dirt of an abandoned field. You are an unusual one-celled creature because you are aware of your surroundings and wonder what is the meaning of it all. You have discovered that a million of your colleagues, doing whatever it is you do, can be found in a mere cupful of dirt. And you are beginning to form a hazy notion of how many cupfuls of dirt there might be in this particular universe. Your scientists tell you that above the ground are creatures too large to imagine, some of them composed of billions of cells. Putting all this together, you try to calculate how many cells there may be, but your mind kind of quits on you. The same thing happens when I think about galaxies too long.

We chat about the distances to other galaxies, but again words are easier than reality. Let's say a certain galaxy shows a certain redshift that tells us it is on the order of a billion light-years away. Okay, but what does that mean? Take a spaceship traveling at 18,000 miles an hour, roughly the speed of a shuttle in orbit. (Yes, starships presumably would travel at significant fractions of the speed of light, but relativistic velocities are pretty much incomprehensible themselves. Just going all the way around the Earth every 90



# of Galaxies

by John P. Wiley, Jr.

minutes would be unsettling.) How long would it take that pokey ship to arrive? If it had left Earth on January 1, 1999, traveling at 18,000 miles an hour, the ship would arrive at the distant galaxy in only 37 trillion years — and the crew would have had to reproduce itself many, many times.

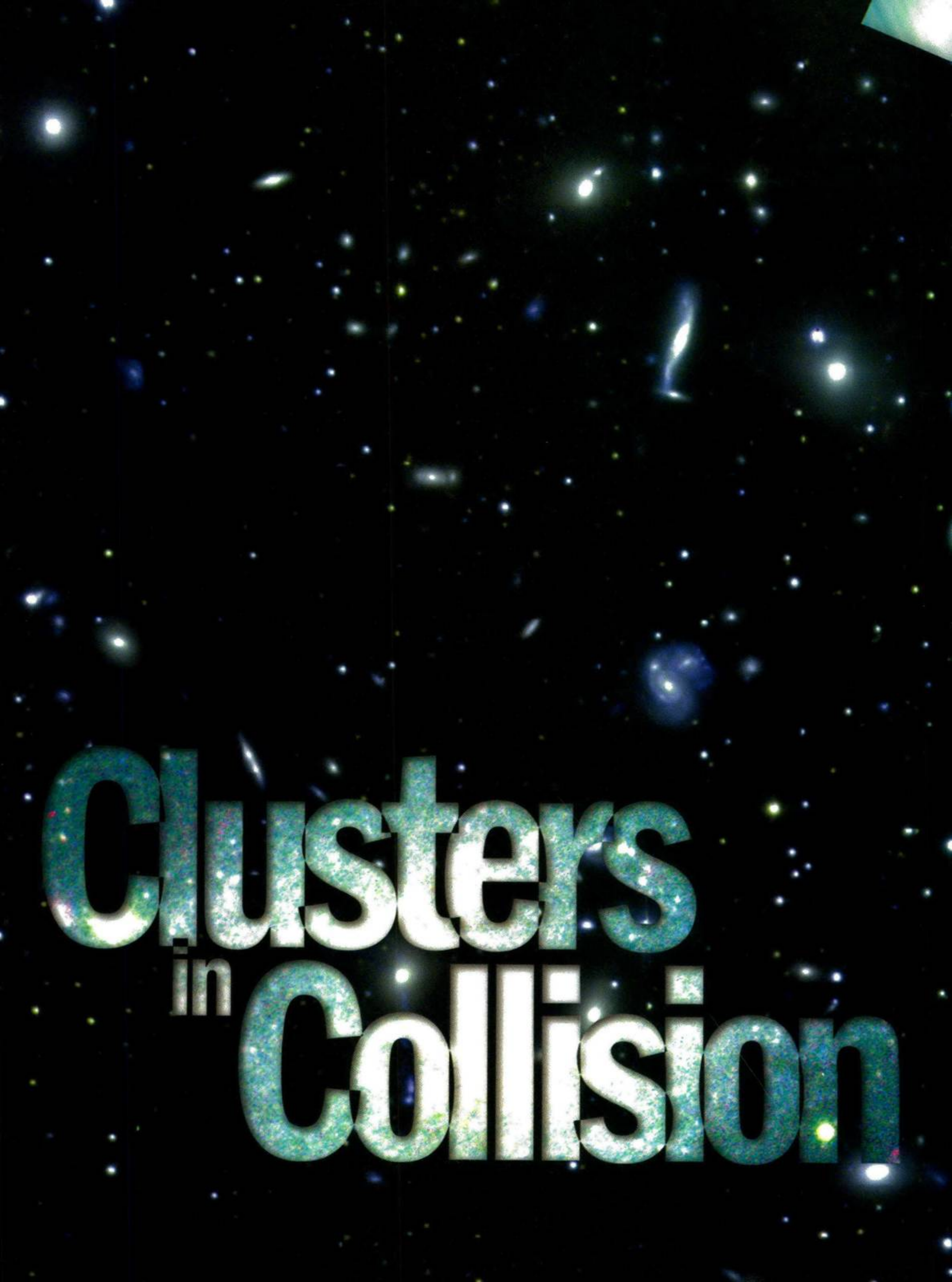
New understandings of galaxies come along almost as rapidly as the farthest galaxies are receding from us. As this was being written, ultraluminous far infrared galaxies (ULIRGs) were in the headlines. Light at those wavelengths passes right through the dust clouds that can completely obscure celestial objects at visible wavelengths. Many ULIRGs appear to be interacting galaxies with bridges and tails, the enormous luminosities caused by bursts of star formation or matter falling into black holes.

Out of what once was simply the far infrared background, itself discovered only a few years ago, we can now resolve individual galaxies. We are finding dusty, young galaxies that already existed when the universe was only one eighth of its present age. "Normal" galaxies were forming stars much earlier than we had thought. Obviously, their precursors existed much earlier still, a fact that will make life that much more difficult for those brave souls who develop theories of galaxy formation.

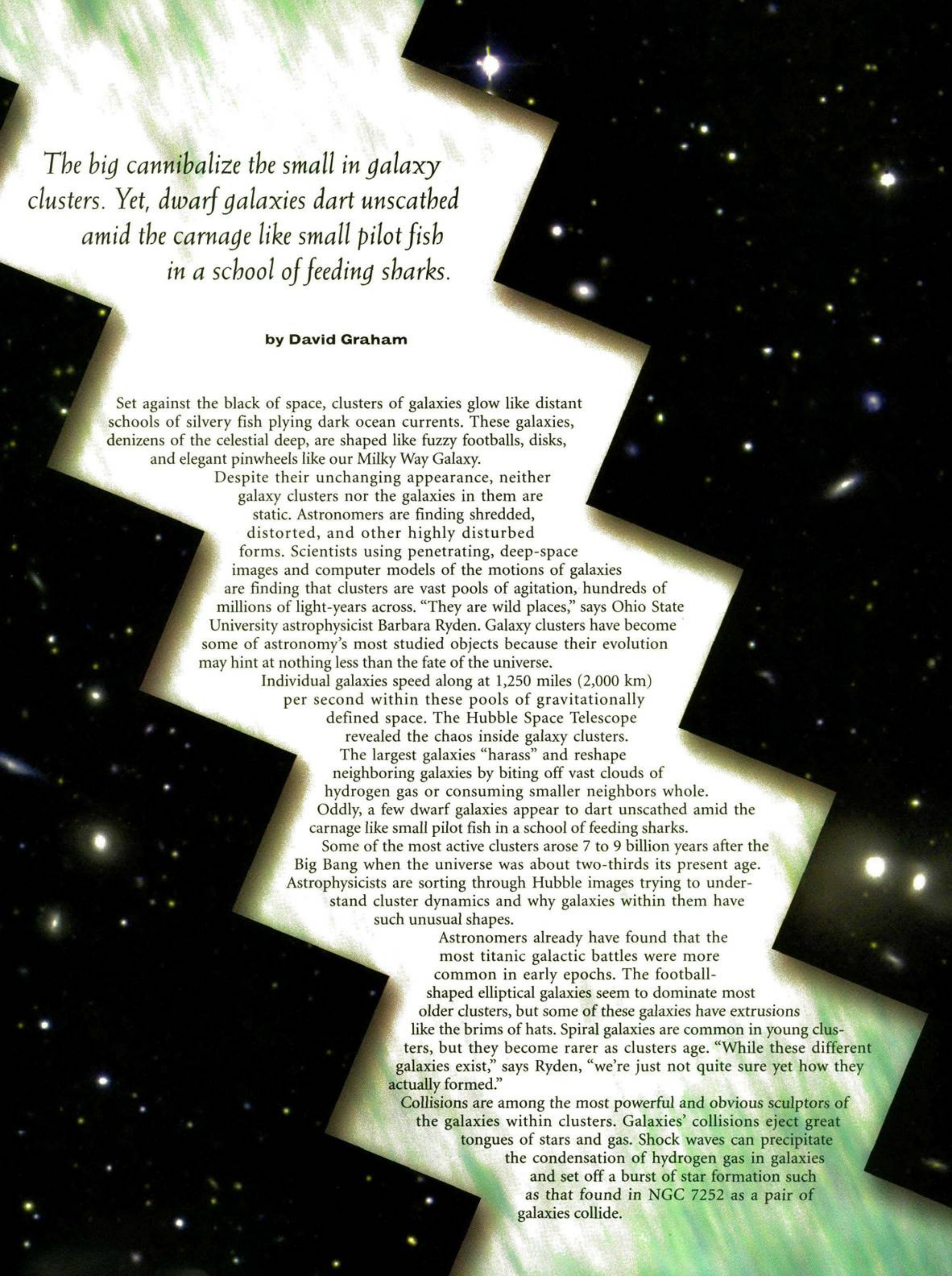
It's fun to learn about things so large, so far away, and so far distant in time. In thinking about the details, however, we forget to think about the sheer size of the universe and the number of things in it. Supposedly, some "primitive" societies had number systems that went "1, 2, 3, many." Our number system can put a name to anything, up to and beyond the googolplex (10 to 10^{100} power). For the human mind in actual practice, however, there comes a point of "too many to count." The number of galaxies in the universe, not to mention the numbers of objects in those galaxies, falls into that category.

In the end, reading about or hearing the facts about galaxies is necessary but not sufficient. You need a feel for them. So some day when there's a quiet moment, pick up one of the Hubble Deep Fields, north or south. Just look at it, galaxies of all sizes and shapes as far as the Hubble and you can see. Relax, become calm, and just look. Do not let yourself think such thoughts as "Well, there are so many galaxies per square inch in this image and it represents so many square degrees of the sky. Therefore. . . ." Just look until you feel yourself falling into the picture, falling through space past galaxy after galaxy after galaxy. Even though the universe is finite, this little exercise may be the closest your mind comes to comprehending infinity in this lifetime.

John Wiley, Jr., is a science editor at Smithsonian *magazine and author of* Natural High, *a collection of essays published in 1994. He knows exactly how to count snow geese.*



Clusters in Collision



The big cannibalize the small in galaxy clusters. Yet, dwarf galaxies dart unscathed amid the carnage like small pilot fish in a school of feeding sharks.

by David Graham

Set against the black of space, clusters of galaxies glow like distant schools of silvery fish plying dark ocean currents. These galaxies, denizens of the celestial deep, are shaped like fuzzy footballs, disks, and elegant pinwheels like our Milky Way Galaxy.

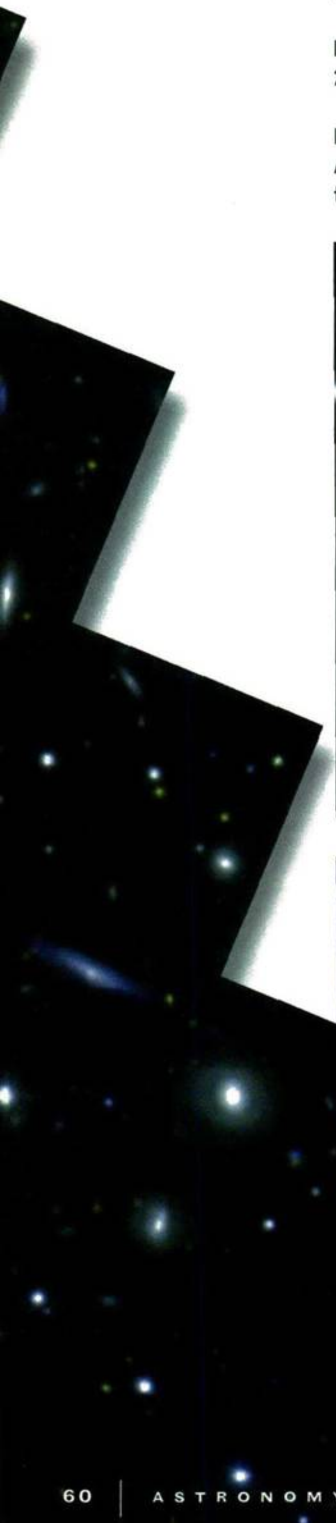
Despite their unchanging appearance, neither galaxy clusters nor the galaxies in them are static. Astronomers are finding shredded, distorted, and other highly disturbed forms. Scientists using penetrating, deep-space images and computer models of the motions of galaxies are finding that clusters are vast pools of agitation, hundreds of millions of light-years across. "They are wild places," says Ohio State University astrophysicist Barbara Ryden. Galaxy clusters have become some of astronomy's most studied objects because their evolution may hint at nothing less than the fate of the universe.

Individual galaxies speed along at 1,250 miles (2,000 km) per second within these pools of gravitationally defined space. The Hubble Space Telescope revealed the chaos inside galaxy clusters. The largest galaxies "harass" and reshape neighboring galaxies by biting off vast clouds of hydrogen gas or consuming smaller neighbors whole. Oddly, a few dwarf galaxies appear to dart unscathed amid the carnage like small pilot fish in a school of feeding sharks.

Some of the most active clusters arose 7 to 9 billion years after the Big Bang when the universe was about two-thirds its present age. Astrophysicists are sorting through Hubble images trying to understand cluster dynamics and why galaxies within them have such unusual shapes.

Astronomers already have found that the most titanic galactic battles were more common in early epochs. The football-shaped elliptical galaxies seem to dominate most older clusters, but some of these galaxies have extrusions like the brims of hats. Spiral galaxies are common in young clusters, but they become rarer as clusters age. "While these different galaxies exist," says Ryden, "we're just not quite sure yet how they actually formed."

Collisions are among the most powerful and obvious sculptors of the galaxies within clusters. Galaxies' collisions eject great tongues of stars and gas. Shock waves can precipitate the condensation of hydrogen gas in galaxies and set off a burst of star formation such as that found in NGC 7252 as a pair of galaxies collide.



Previous page: The Hercules Cluster is rich in spiral and irregular galaxies as well as interacting and merging galaxy pairs. The blue star-forming disks of spirals contrast with the neutral or yellowish, older populations of stars. William C. Keel/University of Alabama

Less violent mergers also are frequent in galaxy clusters. Larger galaxies retain their shape as they subsume smaller galaxies. However, some elliptical galaxies are thought to be formed in more violent collisions of smaller equals.

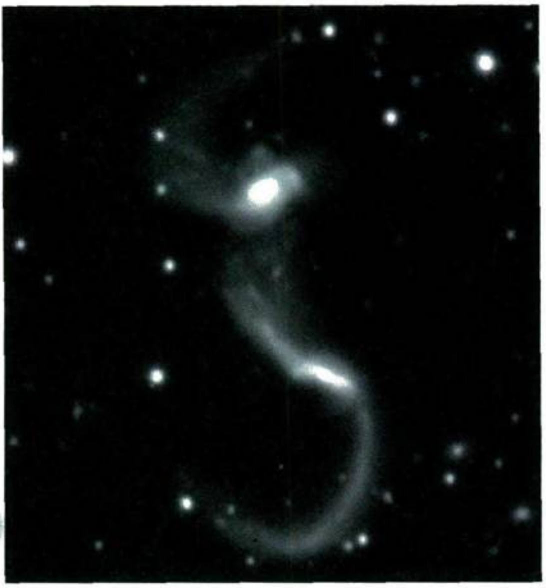
Sleeping Beauty and a Whale

The collisions help explain why there are more ellipticals later in time. "Something in the cluster environment changes normal spirals to ellipticals," says Neta Bahcall of Princeton University. For example, about 50 percent of the galaxies in clusters that exist 7 billion years after the Big Bang are spirals. However, spirals account for only about 20 percent of the galaxies about 12 billion years after the birth of the universe. By contrast, about 70 percent of the galaxies that are not in clusters are spirals.

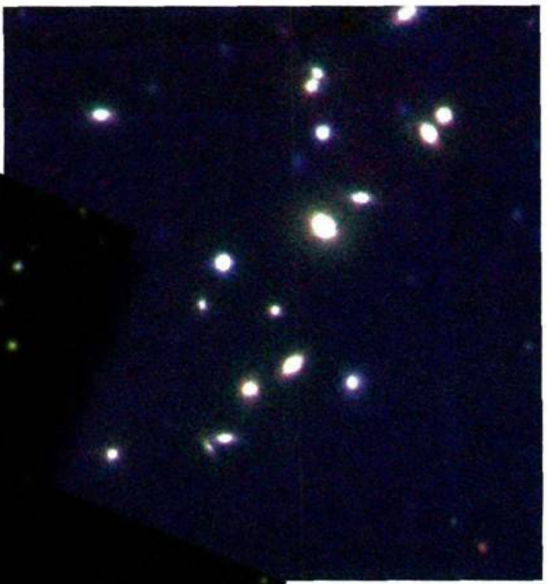
Mergers can generate schizophrenic offspring, preserving parts of the original parents. In M64, the Blackeye Galaxy, a collision between a large and a small galaxy has created a disk galaxy whose outer regions rotate one direction while the inner regions rotate the opposite way.

Perhaps the most flamboyant collisions occur near the cores of great clusters, such as Abell 3827. A supergiant cD galaxy, a bloated whale, lurks near the middle of it. Astronomers have images of the galaxy gobbling up five galaxies caught in its

Below: The interacting spiral galaxy pair in Hydra — Arp 252, or "The Question Mark." William C. Keel/University of Alabama



Bottom: The existence of old galaxy clusters such as Abell 851 imply that gravity is insufficient to overcome the expansion of the universe. Subaru Telescope

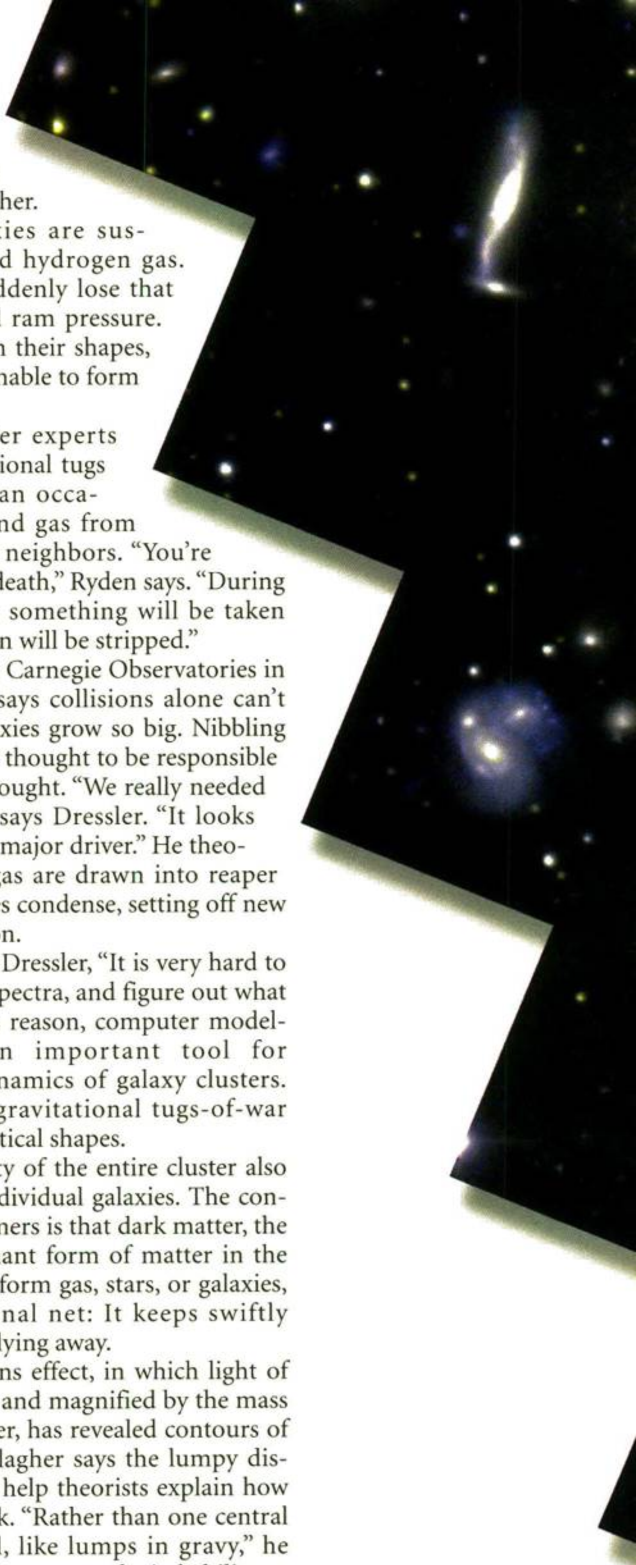


This color-composite image of two merging galaxies shows an active galaxy nucleus (white and red bull's-eye), a star-forming region (blue), and splayed galactic arms (green). The red objects in the lower part of the image are more distant galaxies. European Southern Observatory

great gravitational maw. "The biggest galaxy in the cluster becomes very big indeed," says Ryden. The addition of mass enhances Abell 3827's cannibalism, as astronomers term such voracious consumption of neighbors.

A surprising thing happens to stars during devastating galactic collisions: nothing. Even though they might look crowded from a distance, galaxies are mostly empty space. The odds of a star in one galaxy hitting a star in a colliding galaxy are remote. Stars in each of two colliding galaxies may jiggle, but they keep their positions relative to one another. "The faster you are moving, the less damage you get," says John S. Gallagher, a University of Wisconsin astrophysicist who studies clusters.

Astronomers believe galaxies need not collide at all to wreak great damage on one another. In fact, some of the most obvious disruptions they observe occur without a collision. "This is a very complex ballet among the galaxies, and we don't have great seats, so it's hard to understand all of what's happening," says Gallagher.



Stars in the galaxies are suspended in hot ionized hydrogen gas. However, they can suddenly lose that gas by a process called ram pressure. Without gas they retain their shapes, but these galaxies are unable to form new stars.

Many galaxy-cluster experts also think that gravitational tugs from large galaxies can occasionally pluck stars and gas from the outskirts of small neighbors. "You're going to be nibbled to death," Ryden says. "During every such encounter, something will be taken away — the outer region will be stripped."

Alan Dressler, of the Carnegie Observatories in Pasadena, California, says collisions alone can't explain how some galaxies grow so big. Nibbling and other processes are thought to be responsible for what nature has wrought. "We really needed another mechanism," says Dressler. "It looks like something else is a major driver." He theorizes that streams of gas are drawn into reaper galaxies, where the gases condense, setting off new rounds of star formation.

Unfortunately, adds Dressler, "It is very hard to look at a picture, take spectra, and figure out what is happening." For this reason, computer modeling has become an important tool for understanding the dynamics of galaxy clusters. Models suggest that gravitational tugs-of-war mold galaxies into elliptical shapes.

The collective gravity of the entire cluster also exerts a pressure on individual galaxies. The consensus among astronomers is that dark matter, the mysterious and dominant form of matter in the universe that does not form gas, stars, or galaxies, acts like a gravitational net: It keeps swiftly moving galaxies from flying away.

The gravitational-lens effect, in which light of a distant galaxy is bent and magnified by the mass of an intervening cluster, has revealed contours of mass distribution. Gallagher says the lumpy distribution of mass may help theorists explain how harassment might work. "Rather than one central core, there are several, like lumps in gravy," he says. "This lumpiness increases galaxies' ability to harass neighbors."

Dressler suspects that several processes operate within clusters. "You have a wonderful suite of activities and processes that can affect the shapes of galaxies, and they probably all play a role," he says.

Bahcall agrees: "Everything in the cluster is dynamic. Nothing stands still. Moving more than 1,250 miles (2,000 km) per second through gas of millions of degrees can have all kinds of effects."

Astronomers in recent years have focused on another confounding type of galaxy: dwarfs that seem to be immune to their large neighbors.

These oddballs swarm throughout clusters. Some dwarfs themselves are elliptically shaped. Some are irregularly shaped. Yet, they move about unscathed by large galaxies shadowing them.

Somehow, Dwarfs Survive

Ryden studies the 1,000 or so dwarfs in the Virgo Cluster, each of which contains only about 100 million stars. That is 0.1 percent of the number of stars of the average galaxy. "You'd think these tiny, fluffy things would be raw meat for the bigger brutes in the cluster," says Ryden. There are fewer dwarfs toward the center of clusters, suggesting some may have been eaten. Yet farther out, dwarfs seem not to be harassed. Ryden and her colleagues want to find out why.

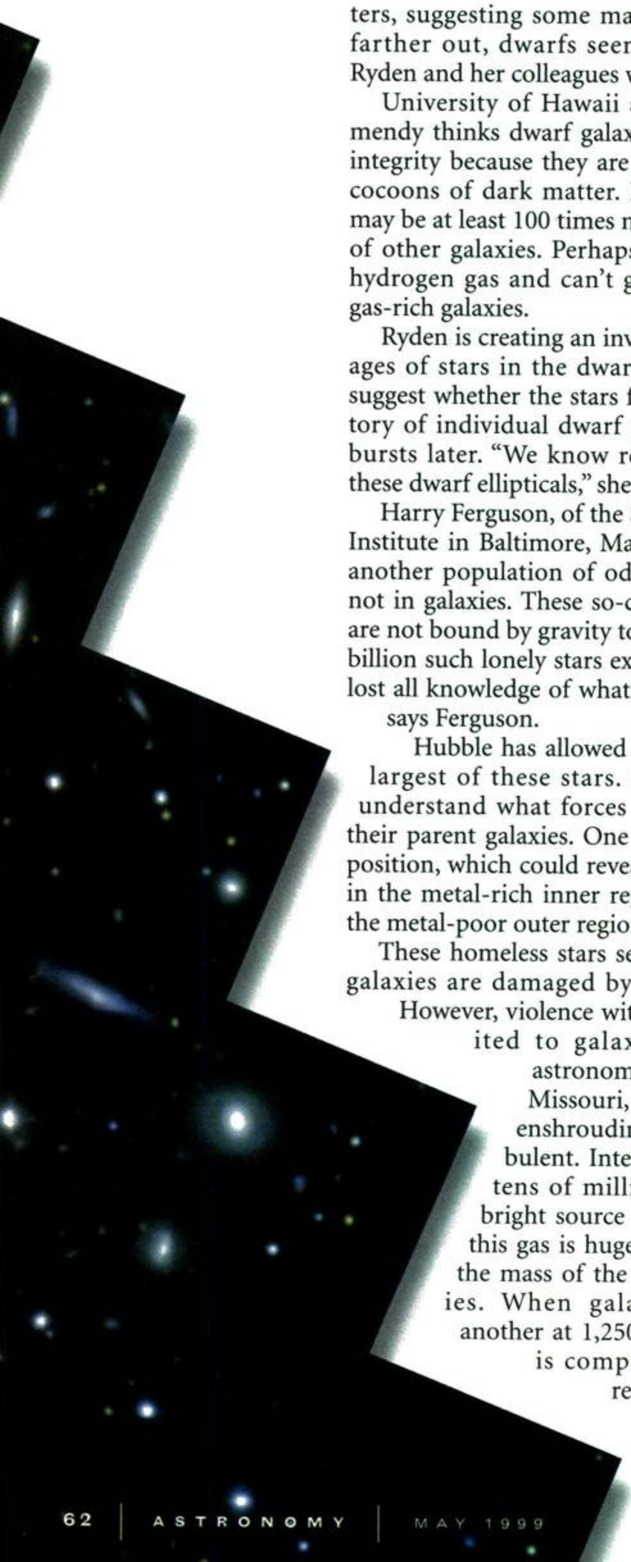
University of Hawaii astronomer John Kormendy thinks dwarf galaxies may maintain their integrity because they are shrouded in protective cocoons of dark matter. He thinks the cocoons may be at least 100 times more massive than those of other galaxies. Perhaps dwarfs also lost their hydrogen gas and can't generate new stars like gas-rich galaxies.

Ryden is creating an inventory of the types and ages of stars in the dwarfs. Her inventory may suggest whether the stars formed early in the history of individual dwarf galaxies or in periodic bursts later. "We know remarkably little about these dwarf ellipticals," she says.

Harry Ferguson, of the Space Telescope Science Institute in Baltimore, Maryland, is inventorying another population of oddballs: individual stars not in galaxies. These so-called intergalactic stars are not bound by gravity to any galaxy. Perhaps 10 billion such lonely stars exist. "They seem to have lost all knowledge of what galaxy they belong to," says Ferguson.

Hubble has allowed astronomers to see the largest of these stars. Ferguson is trying to understand what forces eject these stars from their parent galaxies. One clue lies in their composition, which could reveal whether they formed in the metal-rich inner regions of a galaxy or in the metal-poor outer regions of a galaxy.

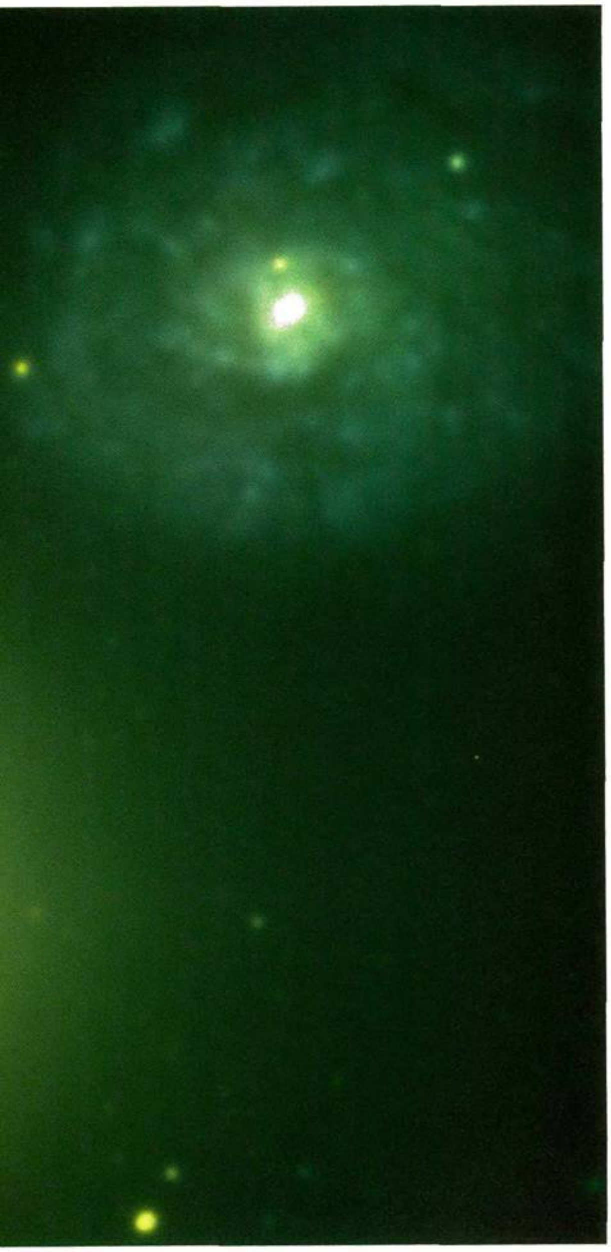
These homeless stars seem to underscore that galaxies are damaged by violent interactions. However, violence within clusters is not limited to galaxies. Jack Burns, an astronomer at the University of Missouri, is finding that the gas enshrouding galaxies can be turbulent. Intergalactic ionized gas is tens of millions of degrees and a bright source of x rays. The mass of this gas is huge — three to five times the mass of the stars shining in galaxies. When galaxies approach one another at 1,250 miles per second, gas is compressed. X-ray images reveal shock waves propagating through this medium. "The gas turns out to be much more exciting than we thought just a few years ago," says Burns. More detailed views of cluster dynamics are giving astronomers more insight about their evolution and the evolution of the universe.



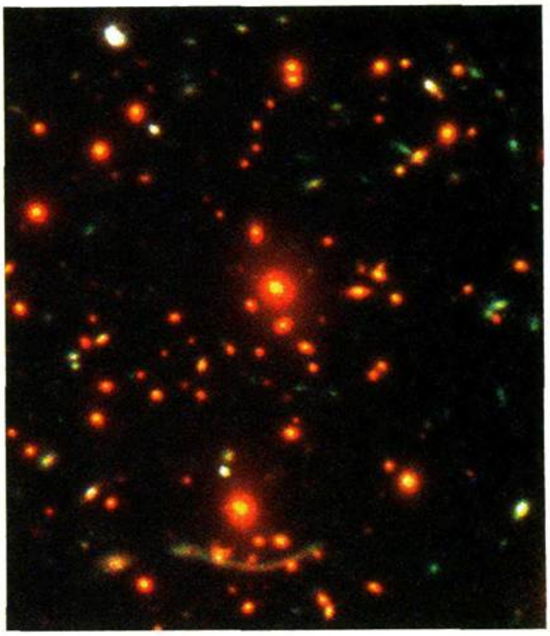
Older clusters, those within 1 billion light-years of Earth, still have violent interactions, but they are more peaceful than younger clusters 6 billion light-years from Earth.

"Six billion years ago, the clusters really were different," says Dressler. "Galaxies and clusters seem to be more worn out now, like things are running down." By looking at samples of clusters even earlier, at some 8 to 9 billion light-years out, astronomers have been able to make a striking proposal about the future universe.

Bahcall and others say the universe does not contain enough matter, and thus sufficient gravitational force, to halt its expansion. This is called an open universe.



A blue filter highlights young-star clusters of the spiral galaxy NGC 4647, situated near the bright elliptical galaxy M60 (NGC 4649). Both galaxies are in the Virgo Cluster. William C. Keel/University of Alabama



Top: M87 (NGC 4486) is a giant elliptical galaxy at the heart of the Virgo Cluster. Anglo-Australian Telescope Board

Above: The cluster Abell 370 contains many elliptical galaxies. The light of a very distant object is deformed by the cluster and gives rise to one of the most prominent gravitational arcs known. European Southern Observatory

In such a low-density universe, many clusters could arise, Bahcall says, because a weaker gravitational tug would not inhibit growth of galaxies and clusters. On the contrary, a high-density universe would have overwhelmed clusters with powerful gravitational forces, stunting their growth.

"From observations, it's very clear that mass density is very low," Bahcall says. She says the universe may contain only 20 to 30 percent of the matter required to halt its expansion. It will fall to a new generation of more powerful telescopes to prove or disprove Bahcall's view.

Two new x-ray satellites, NASA's Chandra X-ray Observatory, to launch this year, and European Space Agency's X-ray Multiple Mirror Telescope, will be able to scrutinize such distant clusters. Their images will give astrophysicists a clearer measure of the density of mass in the universe as well as a census of the types of galaxies in the early universe. Astronomers await those deep-space views. In the mean time, studying clusters halfway to the dawn of the universe "is a hard game to play," says Ferguson. ▣

David Graham is a science reporter for The San Diego Union-Tribune.

Let There Be LIGHT

Subaru and Gemini join the Olympian gods on Mauna Kea.

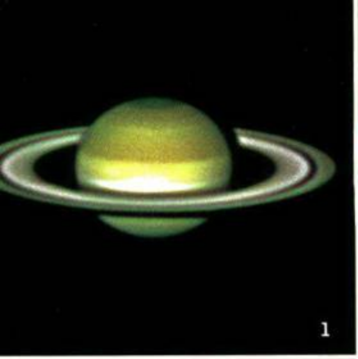
On the summit of a dormant volcano, more than 13,000 feet above the vast Pacific Ocean, two new 8-meter-class telescopes are opening their eyes on the starry sky. Mauna Kea, a designated Science Reserve on the big island of Hawaii, now houses 12 of the world's most state-of-the-art telescopes.

The first of the two new telescopes to see "first light" is the Subaru Telescope, whose 8.3-meter mirror is the world's largest that comes in a single piece. The word "subaru" in Japanese means "getting together" and is the Japanese name for the Pleiades. (There is no relation to the car company of the same name.) On January 28, the National Astronomical Observatory of Japan (NAOJ) announced its successful completion of Subaru's "first light" phase of operation. First light occurs when astronomers test run a telescope to ensure that it's in proper working order.

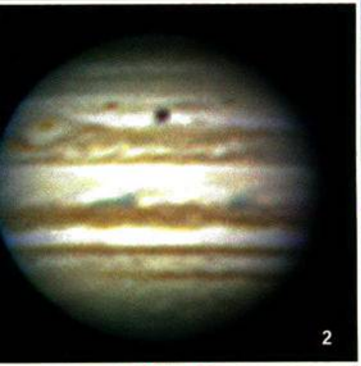
Subaru was designed to boost Japan's optical and infrared observing capabilities. The initial images released by NAOJ prove that Subaru has already met its design goals. To see additional first light images, visit the NAOJ web page at http://www.naoj.org/outreach/press_releases/990128/.

The second of the two new jewels gracing the crown of Mauna Kea is the 8.1-meter Gemini North Telescope. The telescope's moniker comes from the constellation of the same name. Gemini North will have a Southern Hemisphere twin located on Cerro Pachón, Chile, aptly named Gemini South. Gemini North was scheduled to achieve first light in late February (just as this issue was going to press), with Gemini South following about one year later. To keep up with the progress of this international project, visit the Gemini website at http://www.gemini.edu.
— *Kelly Whitt*

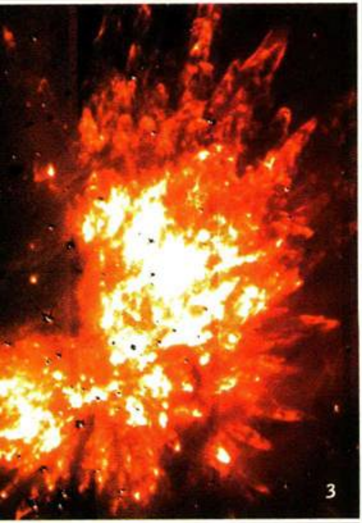
1. In this Saturn image, subtly shaded cloud bands are clearly visible as well as the Cassini Division separating the A and B rings. 2. In this shot from Subaru's optical camera, the Great Red Spot looks out from Jupiter's upper left. The dark spot at upper center is Ganymede, the largest jovian satellite. 3. Subaru zeroes in on the Kleinman-Low (KL) Region of the Orion Nebula. Hidden within the nebula, a 30-solar-mass star still in the process of forming is bellowing winds outward that heat the cold surroundings and stimulate hydrogen molecules to emit light. 4. This gathering of five galaxies, 300 million light-years distant, is known as Hickson Compact Group 40. The galaxies are so close together that they could be in the process of merging into one or two giant elliptical galaxies. 5. Subaru's infrared camera captures the Orion Nebula (M42). The four stars of the Trapezium (center) are ionizing the surrounding gas with their powerful ultraviolet radiation. The KL Region is visible at upper right. All photos: Subaru Telescope, NAOJ



1



2



3

4

5

THE SKY SHOW

May keeps observers hopping with three lunar occultations, a meteor shower, and the appearance of all eight planets. by Martin Ratcliffe and Alister Ling

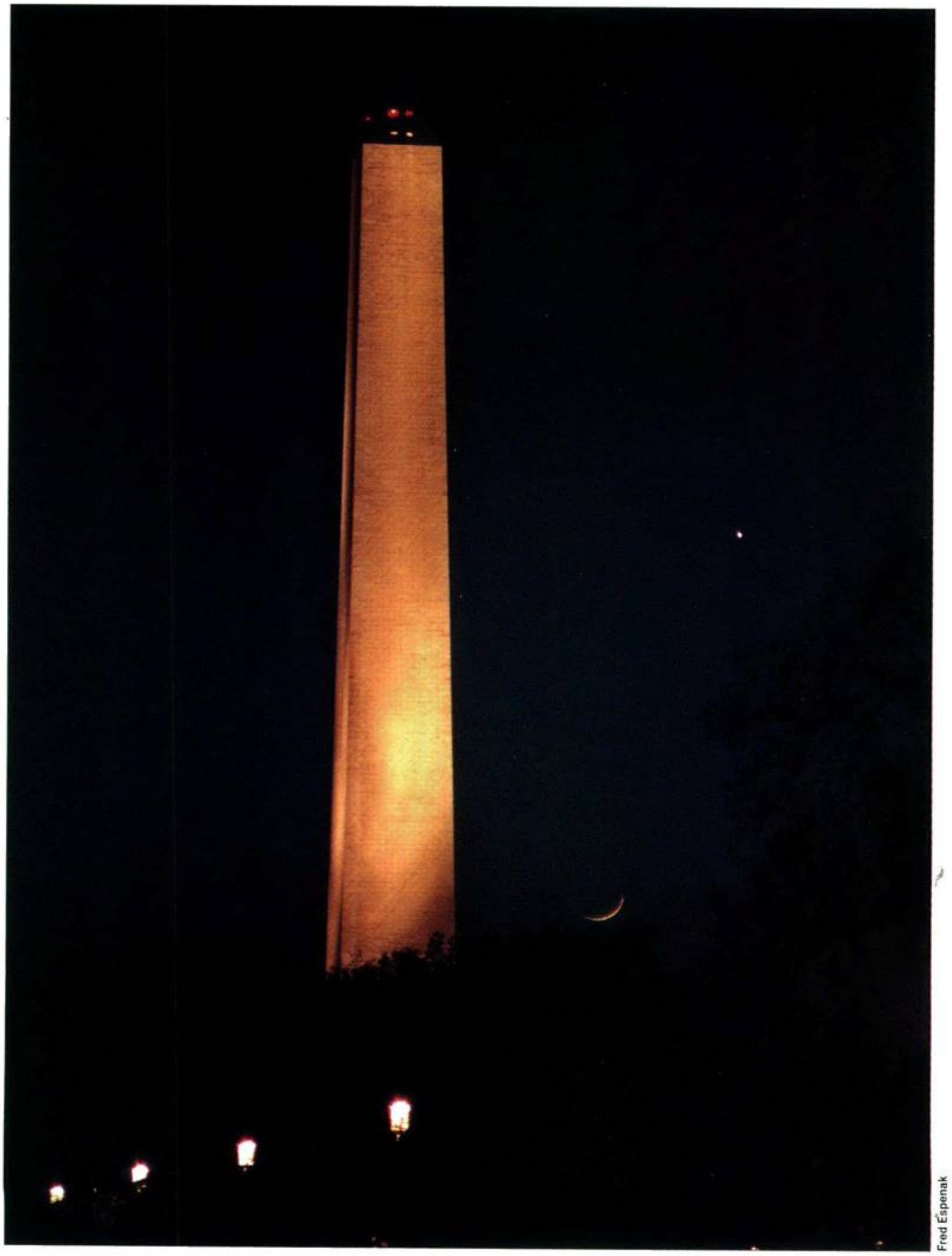
May is a month of contrasts. A cooling shower of rain can quickly interrupt the warmth of the coming summer. Longer periods of daylight precede shorter nighttime hours. In the sky, the relatively nearby planets gleam and dazzle, while the dim and far-off galaxies act as a backdrop.

The planets continue their wonderful performance as orangy-red Mars greets the darkening southeastern sky after sunset, while blazing-white Venus vies for equal attention high in the west.

Venus begins the month at magnitude –4.1 between the two stars that mark the horns of Taurus the Bull. By May 9, this "evening star" lies less than 2° north of the open star cluster M35 in the constellation Gemini the Twins. Two days later, on May 11, Venus lies at its northernmost declination of the year (26°) — a position that helps make this the best time to view Venus from the Northern Hemisphere. Venus ends the month just 4° south of the bright star Pollux in Gemini and will reach its greatest elongation east of the sun in the second week of June.

Even in a small telescope, observers can see a noticeable change in the phase of Venus (see "Venus Rising," page 80, February 1999). Early in May, Venus displays a 69-percent-illuminated gibbous phase that shrinks to 55-percent by the end of the month.

You'll also see a change in the planet's apparent size as it moves closer to Earth — Venus grows from 16" to 21" across. The increasing size more than makes up for the shrinking phase, causing the planet to brighten slightly this month, to magnitude –4.2. Start following Venus through a telescope now; next month its rate of growth will double. On May 18, a crescent moon glides slightly more than 5° south of Venus. The planet also


Fred Espenak

On the evening of May 18, a slim crescent moon passes near bright Venus — recreating this striking pose seen from Washington, D.C.

MAY 1999

1 Mercury passes 1.7° south of Jupiter, 6 A.M. EDT
Mars is closest to Earth (53.8 million miles away), 1 P.M. EDT

2 The moon is at apogee (252,449 miles from Earth), 2:15 A.M. EDT

5 Eta Aquarid meteor shower peaks (page 73)

7 The moon passes 0.9° north of Neptune, 1 P.M. EDT

8 The moon passes 0.7° north of Uranus, noon EDT
Last quarter moon is at 1:28 P.M. EDT

13 The moon passes 4° south of Jupiter, 1 A.M. EDT
Mercury passes 0.7° north of Saturn, 2 P.M. EDT

15 New moon is at 8:05 A.M. EDT
The moon is at perigee (221,887 miles from Earth), 11:08 A.M. EDT

16 The moon passes 0.9° north of Aldebaran, 9 A.M. EDT (page 74)

18 The moon passes 6° south of Venus, 11 A.M. EDT

20 Jupiter is at perihelion (460.2 million miles from the sun), 6 A.M. EDT

21 The moon passes 0.7° north of Regulus, 11 P.M. EDT (page 74)

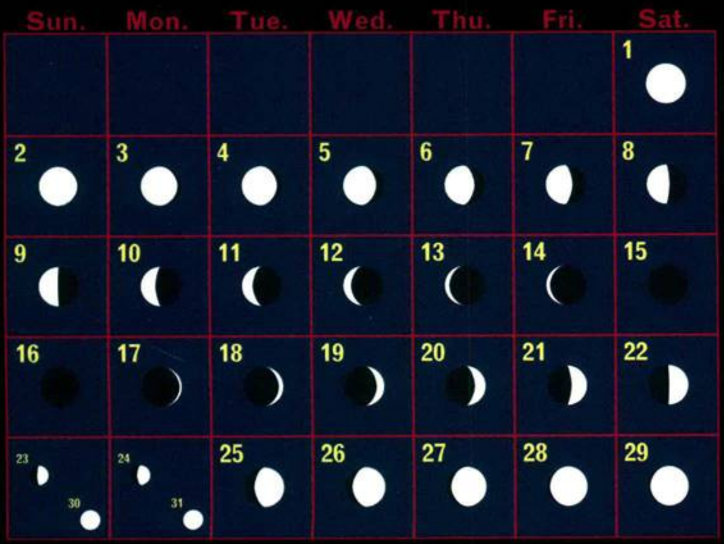
22 First quarter moon is at 1:34 A.M. EDT

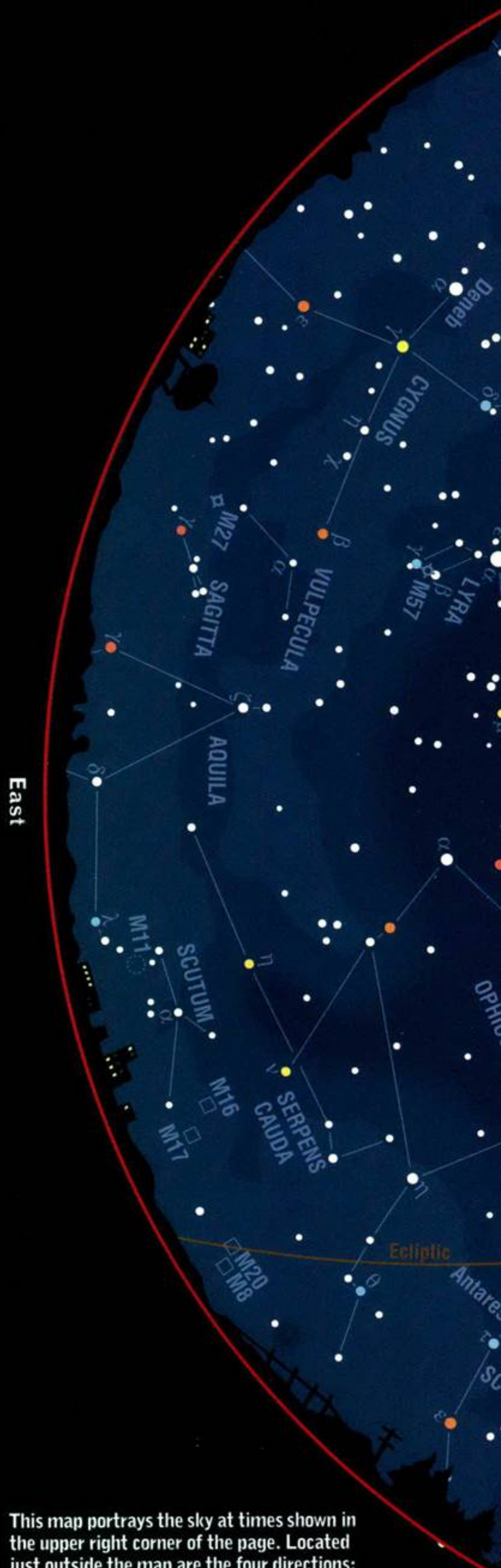
25 Mercury is in superior conjunction, 2 P.M. EDT

26 The moon passes 5° north of Mars, 7 A.M. EDT

29 The moon is at apogee (252,524 miles from Earth), 4:16 A.M. EDT

30 Full moon is at 2:40 A.M. EDT
Venus passes 4° south of Pollux, 6 P.M. EDT
Pluto is at opposition, 8 P.M. EDT (page 75)

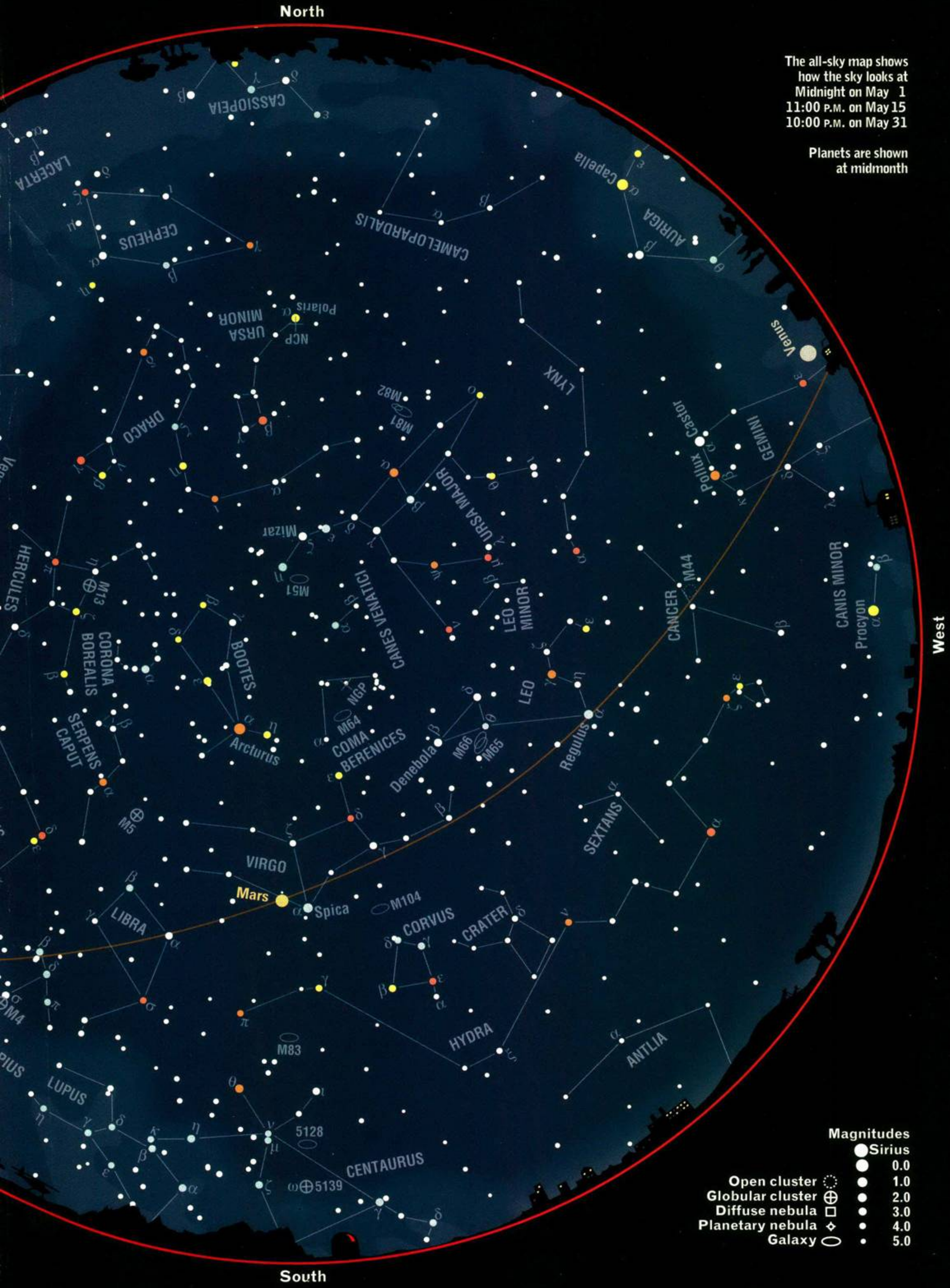




This map portrays the sky at times shown in the upper right corner of the page. Located just outside the map are the four directions: north, south, east, and west. To find stars above your horizon, hold the map overhead and orient it so a direction label matches the direction you're facing. The stars above the map's horizon now match what's in the sky.

The all-sky map shows
how the sky looks at
Midnight on May 1
11:00 P.M. on May 15
10:00 P.M. on May 31

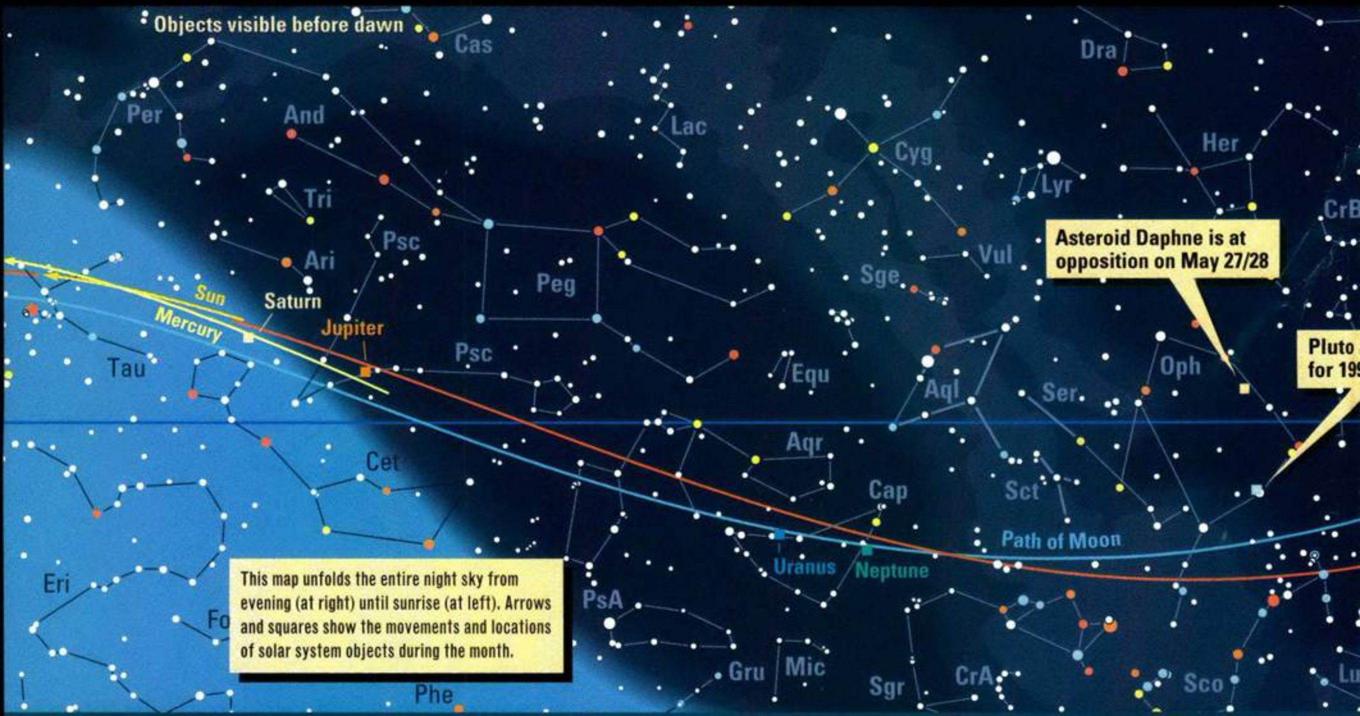
Planets are shown
at midmonth


North
CASSIOPEIA
LACERTA
CEPHEUS
CAMELOPARDALIS
Capella
AURIGA
URSA MINOR
Polaris
NCP
Venus
DRACO
M82
M81
LYNX
Castor
Pollux
GEMINI
URSA MAJOR
Mizar
M51
CANES VENATICI
LEO MINOR
M44
CANCER
CANIS MINOR
Procyon
West
HERCULES
M13
CORONA BOREALIS
BOOTES
NGP
M64
COMA BERENICES
Denebola
M66
M65
LEO
Regulus
Arcturus
SERPENS CAPUT
M5
SEXTANS
VIRGO
Mars
Spica
M104
LIBRA
CORVUS
CRATER
M4
HYDRA
M83
ANTLIA
LUPUS
5128
CENTAURUS
ω 5139
South

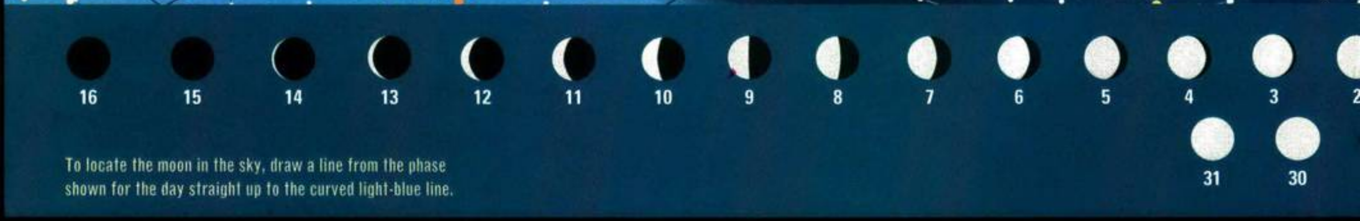
Magnitudes
Sirius
0.0
1.0
2.0
3.0
4.0
5.0

Open cluster
Globular cluster ⊕
Diffuse nebula ☐
Planetary nebula
Galaxy

THE PATH OF THE PLANETS

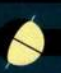
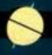
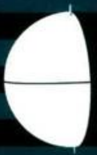
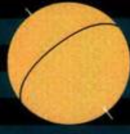

Objects visible before dawn
Cas
Dra
Per
And
Lac
Cyg
Her
Lyr
Tri
CrB
Psc
Asteroid Daphne is at opposition on May 27/28
Ari
Vul
Sun
Saturn
Peg
Sge
Mercury
Jupiter
Pluto
for 19
Tau
Psc
Equ
Oph
Aql
Ser
Cet
Aqr
Cap
Sct
Path of Moon
Uranus
Neptune
Eri
PsA
Fo
Gru
Mic
Sgr
CrA
Sco
Lu
Phe

This map unfolds the entire night sky from evening (at right) until sunrise (at left). Arrows and squares show the movements and locations of solar system objects during the month.


16
15
14
13
12
11
10
9
8
7
6
5
4
3
2
31
30

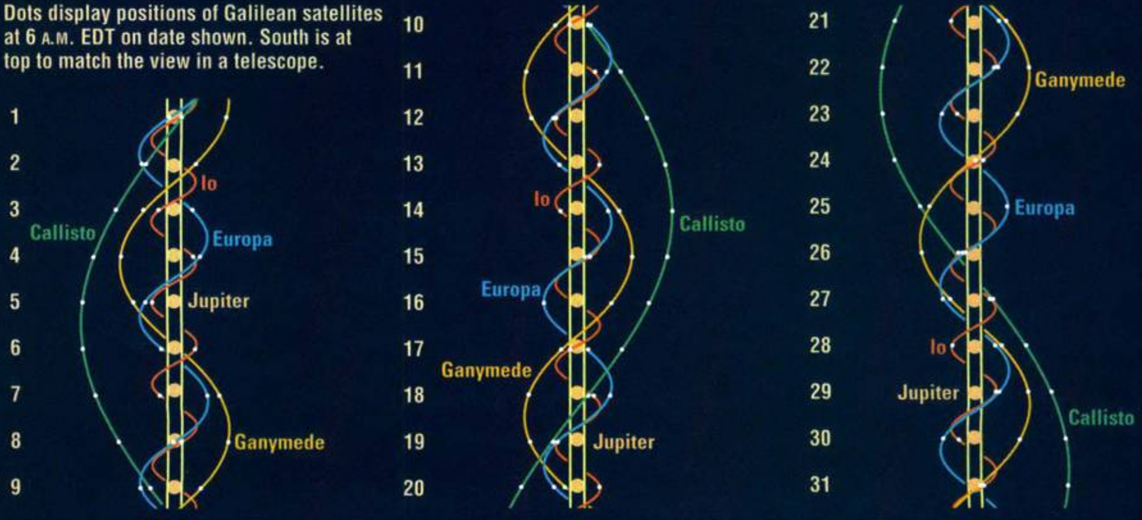
To locate the moon in the sky, draw a line from the phase shown for the day straight up to the curved light-blue line.

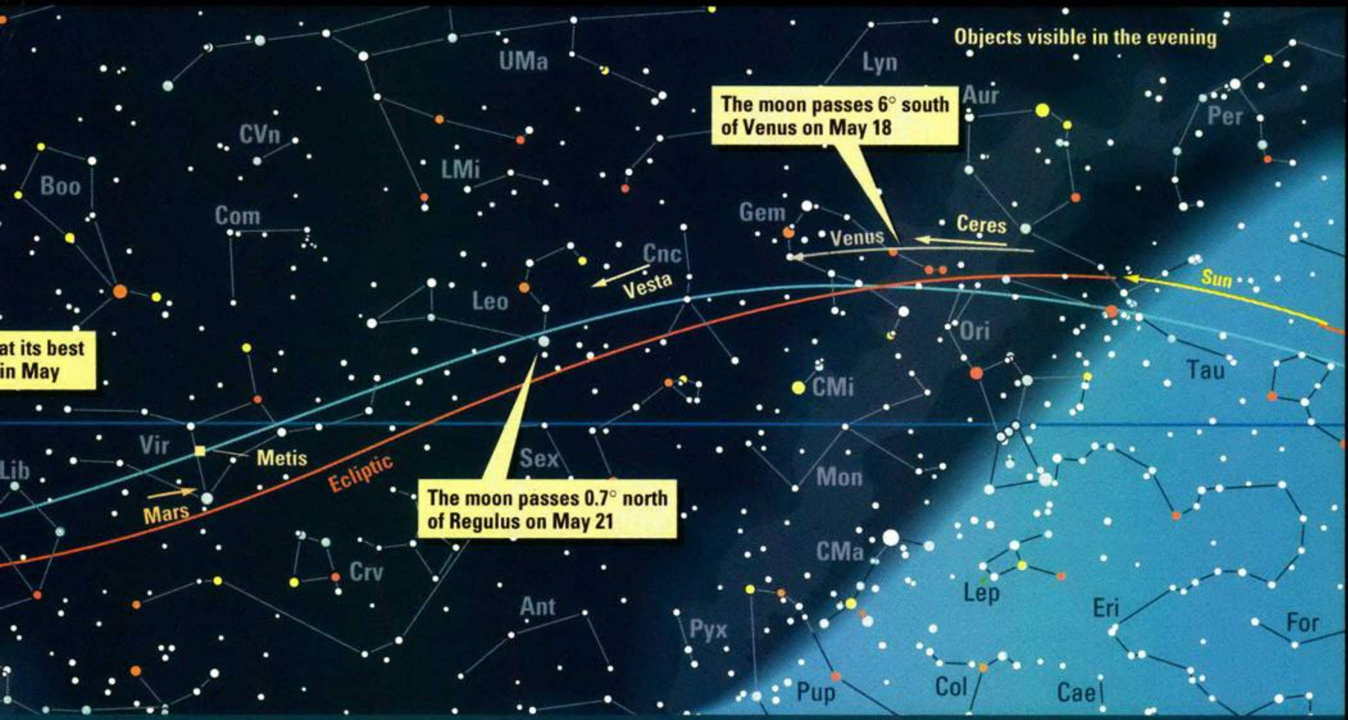
PLANETS	MERCURY	MERCURY	VENUS	MARS	MARS
Date	May 1	May 15	May 15	May 1	May 31
Magnitude	−0.1	−1.0	−4.2	−1.6	−1.1
Angular Size	6.3"	5.3"	18.0"	16.2"	14.4"
Illumination	68%	89%	63%	100%	94%
Distance (AU) from Earth	1.076	1.264	0.928	0.579	0.650
Distance (AU) from Sun	0.427	0.351	0.720	1.582	1.545
Right Ascension (2000.0)	1h06.9m	2h37.8m	6h31.1m	13h59.9m	13h30.8m
Declination (2000.0)	4°10'	13°58'	25°52'	−11°04'	−9°42'

JUPITER'S MOONS

Dots display positions of Galilean satellites at 6 A.M. EDT on date shown. South is at top to match the view in a telescope.



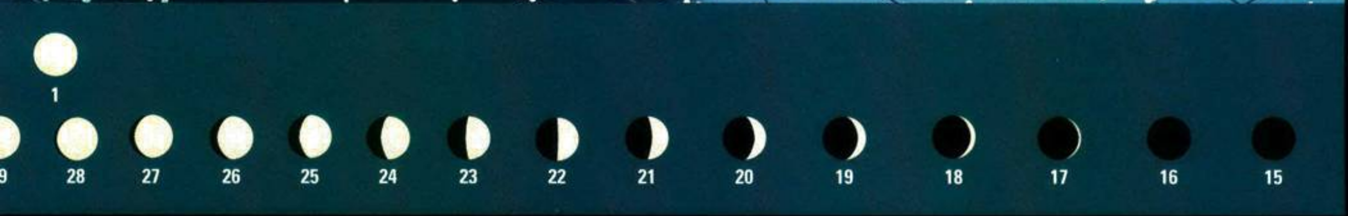

UMa
Lyn
Aur
Per
CVn
LMi
Boo
Com
Gem
Venus
Ceres
Cnc
Vesta
Leo
Sun
Ori
Tau
CMi
Vir
Metis
Ecliptic
Sex
Lib
Mars
Mon
CMa
Crv
Lep
Eri
For
Ant
Pyx
Pup
Col
Cael

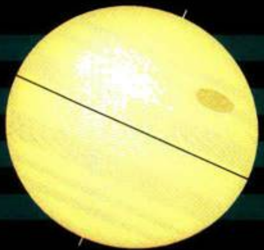
Objects visible in the evening

The moon passes 6° south of Venus on May 18

at its best in May

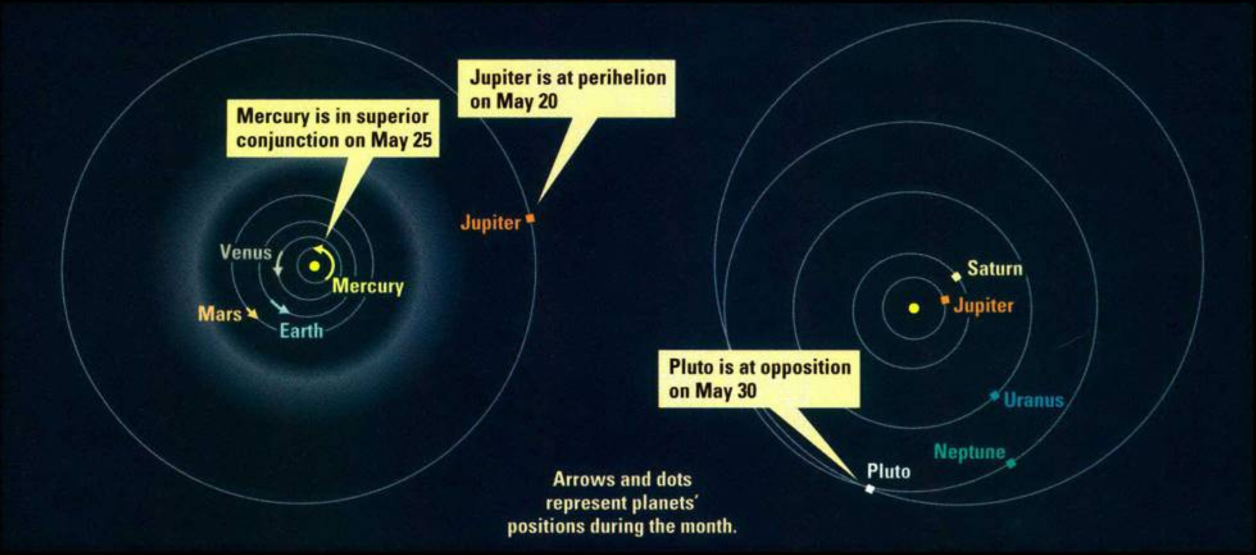
The moon passes 0.7° north of Regulus on May 21


1
9
28
27
26
25
24
23
22
21
20
19
18
17
16
15



JUPITER	SATURN	URANUS	NEPTUNE	PLUTO
May 15	May 31	May 15	May 15	May 15
−2.1	0.4	5.8	7.9	13.7
34.1"	16.4"	3.6"	2.3"	0.1"
100%	100%	100%	100%	100%
5.774	10.113	19.753	29.778	29.204
4.950	9.233	19.901	30.129	30.158
1h20.7m	2h36.9m	21h17.8m	20h26.5m	16h38.8m
7°18'	13°01'	−16°27'	−18°53'	−10°08'

THE PLANETS IN THEIR ORBITS


Jupiter
Venus
Mercury
Mars
Earth
Saturn
Jupiter
Uranus
Neptune
Pluto

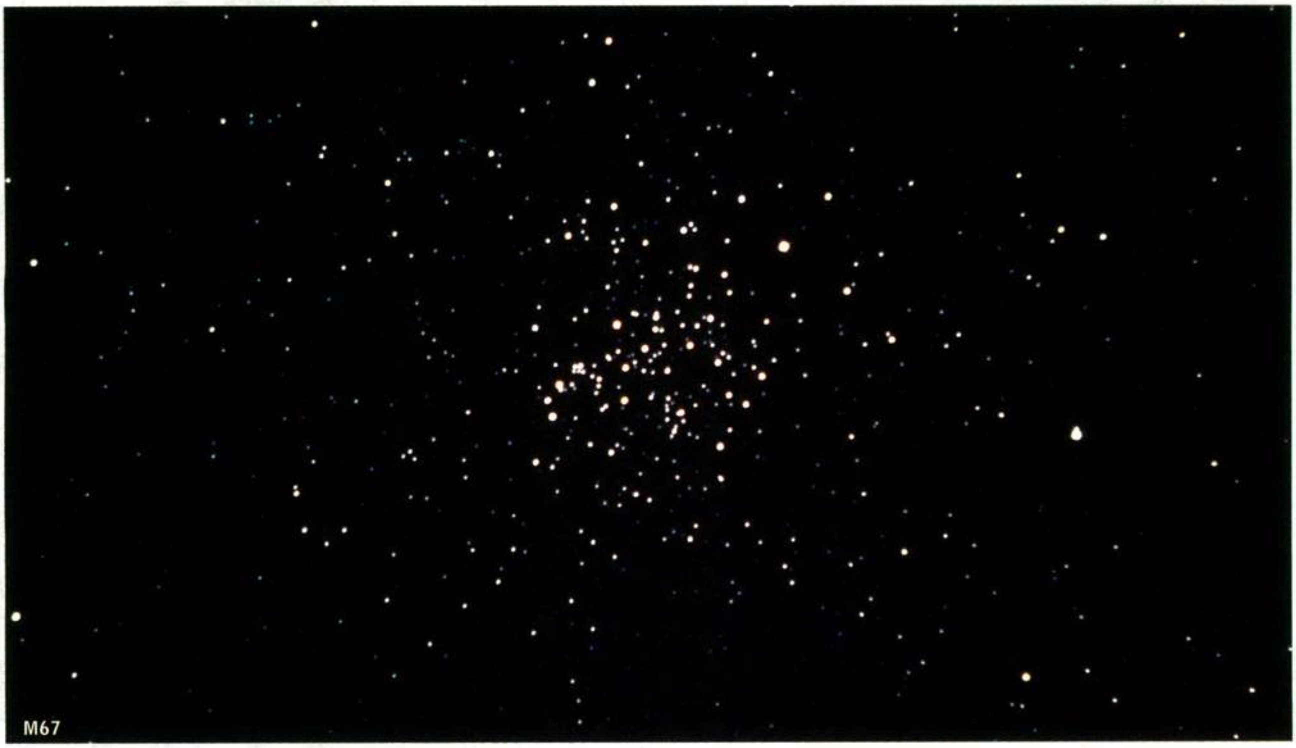
Mercury is in superior conjunction on May 25

Jupiter is at perihelion on May 20

Pluto is at opposition on May 30

Arrows and dots represent planets' positions during the month.

First Views: M67, Cancer's Better Cluster



David Ratledge

When an observer is asked to name the star clusters in Cancer, the first one listed is invariably the Beehive Cluster (M44). Yet the best cluster to look at through most telescopes is surely M67 (NGC 2682). The Beehive is simply too big to impress people unless they look at it through the finderscope or binoculars. Like the Beehive, M67 is also well suited for viewing from the city.

French comet hunter Charles Messier discovered this delightful star cluster with his small refractor in the spring of 1780. His telescope's inferior optics, by today's standards, led him to believe that the cluster contained some nebulosity, but, alas, there is none.

M67 is a modestly compact group of stars, half the size of the full moon. It is a real gem that sports a bright field star on the southeast side and a dozen or two 11th- to 12th-magnitude stars. By increasing the magnification, you'll see even more stars. This is why M67 looks good in the city. Its stars can punch through the light pollution far better than the light from a galaxy. The cluster's stars also appear brighter to us than the brightest stars of the Hercules Cluster (M13). Take a look for yourself. M67 is splashy compared to M13's typically disappointing fuzz through a city-bound 8-inch scope.

Studies of the stars in M67 have shown that a considerable number have evolved into red giants. This means the cluster's age is roughly 10 billion years, second oldest among open star clusters only to the considerably fainter NGC 188 near Polaris.

passes 0.7° south of the faint 8.9-magnitude asteroid Ceres on May 5.

While Venus is the focus in the western sky, the growing altitude of **Mars** draws the eye to the east. The Red Planet is moving toward the 1st-magnitude star Spica, whose contrasting white color draws attention further. Mars begins May shining at its opposition magnitude of –1.6. Its motion against the stars brings it to within 2° of Spica by May 31 and continues to close the gap early next month. A gibbous moon joins this dramatic pairing on May 25.

Normally a planet's position relative to the stars in the night sky shifts daily to the east. Mars, however, is currently moving in retrograde motion against the stars — from east to west. Retrograde motion is a result of the planet's and Earth's combined motion around the sun. Earth's smaller orbit allows it to overtake Mars every 780 days. For a period of two months, Mars appears to move in an opposite direction relative to the stars. Its path loops back in on itself in a westerly direction.

Retrograde motion is the path of the planet relative to the stars, not the daily motion that causes the planet to rise and set, which is always from east to west. You can see this effect by marking the position of Mars relative to the stars of Virgo from late March to June. Another option is to take a series of photographs of Virgo — one every two or three days. Then you'll have a fine sequence of the planet's retrograde motion.

Such images will prove useful for talks at local schools and clubs.

Mars remains a superb sight when viewed through a telescope during May. On the 1st it lies closer to Earth than at any other time during this apparition, some 53.8 million miles away, which makes the planet's disk appear largest. During the first eleven days of the month, Mars stays above 16" in diameter — its best since 1990.

Many of Mars's dark features are most evident in telescopes with apertures of 6 inches and larger. Yet a small telescope can still resolve the major features such as Syrtis Major.

Syrtis Major lies at a martian longitude of 300°. This places the dark feature within the visible hemisphere of Mars as seen by observers in the United States during the last week of May and by Europeans in the third week of May.

It's late summer for the northern hemisphere of Mars, so its polar cap has been diminishing. Can you see any remains of this white crown?

By month's end, Mars is a respectable 14.4" across and has dimmed by about a third, to magnitude –1.1.

As summer approaches, the bright stars of the winter stage drop below the western horizon. Castor and Pollux in Gemini the Twins are taking their last curtain call. Procyon, in the Little Dog, trots obediently along with them. The spring sky puts on its own show with only a handful of bright stars. Yet they too hold a variety of treats.

On the evening of May 21, the first quarter moon approaches Regulus. It looks like it will cover this bright star in Leo, and indeed it will for most observers in the United States. The exact time of occultation depends on your precise location. Another lunar occultation of interest occurs on May 28 when Gamma (γ) Librae, a fine double star, receives a visit from the nearly full moon.

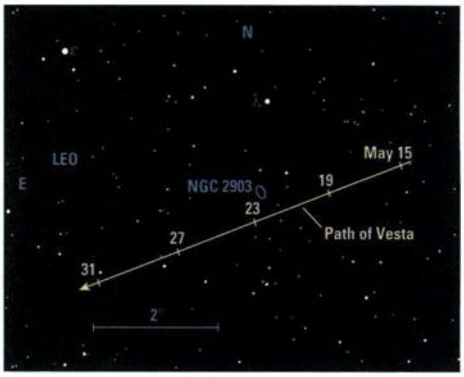
May 5 brings the peak of the Eta Aquarid meteor shower, but a bright waning gibbous moon will interfere with the show.

Although the moon will dampen views of the Eta Aquarids, its late rising time makes the first part of the month an ideal time to search for galaxies in the Virgo Cluster. Double stars and globular clusters also

Asteroid 4 Vesta Is a Guest

When a star dies in a supernova explosion, it can outshine its host galaxy. The ancient Chinese called our Milky Way Galaxy's supernovae "guest stars." Between May 20 and 25, the hunk of rock we call Vesta masquerades as a guest star near the distant large spiral galaxy NGC 2903 in Leo.

Jack Newton

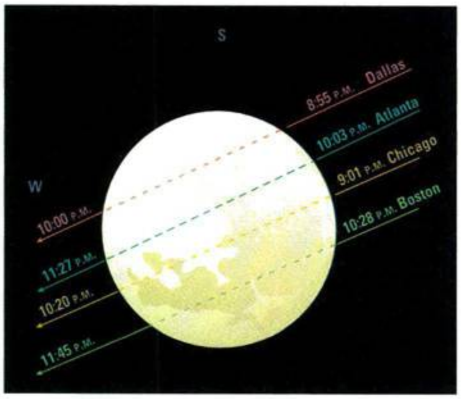


At 9th magnitude, NGC 2903 qualifies as one of the finest NGC galaxies. Vesta comes in at magnitude 7.8, which could be confused with a supernova. Yet at its closest approach on May 23, Vesta lies 30' south of NGC 2903 — too far to be in the galaxy. For the best view, observe from a dark sky site and wait until after midnight when the first quarter moon has set.

The Moon Is Two for One

The disappearance of a star behind the moon's limb is always impressive. Can a double star be twice as good?

On Friday night, May 28, the double star Gamma (γ) Librae will reveal its duplicity to small telescopes. Thanks to the knife-edge of the moon, observers will see the stars, separated by just 0.1", disappear in two steps. Europeans get a chance to scoop North Americans when they watch the moon pass in front of Gamma one lunar month earlier, on the evening of May 1.



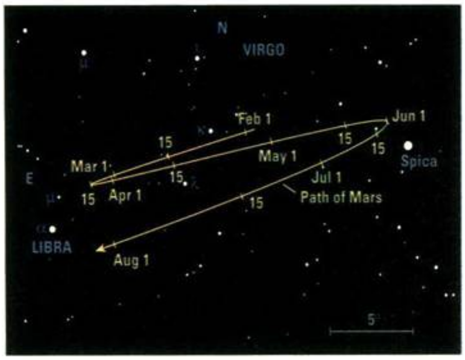
Gamma Librae contains magnitude 4.6 and magnitude 4.8 stars aligned almost east-west. This means the second star will disappear just two-tenths of a second after the first — in the wink of an eye.

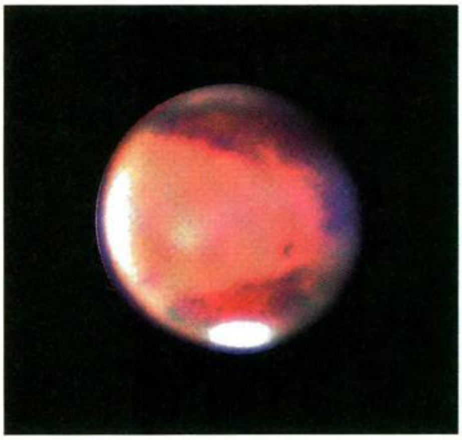
The entire North American continent can see this event. The only exception is the west coast north of California. For detailed times of the events for your home, visit the IOTA website at http://www.sky.net/~robinson/iotandx.htm.

May Is Mars Month

Less than a month after one of its best appearances in years, Mars rises just before sunset. It begins the month with an apparent diameter of 16". By May 31, it will have dimmed by half a magnitude and shrunk in size by 11 percent.

While most people rightly concentrate on martian surface features, you might want to point out the planet's small looping movement across the sky. This retrograde motion is very easy to follow. Use the 1st-magnitude blue-white star Spica in Virgo as a reference point. Mars makes a shallow dive for Spica by the end of May, then stalls and heads back eastward.



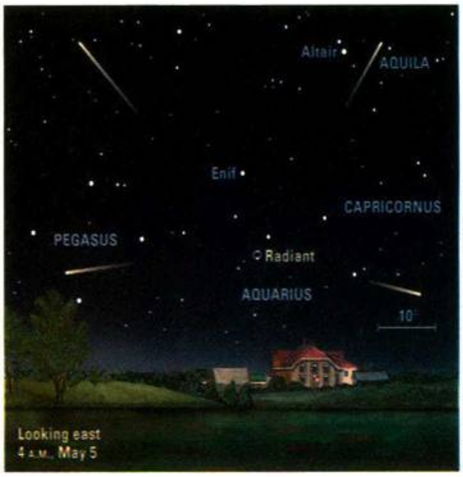

Don Parker

Be sure to enjoy these views, as the planet's apparent size will shrink fairly quickly over the next couple of months. This will leave the late summer skies relatively devoid of evening planets.

Comet Halley's Swift Offspring

The dusty debris of this most famous comet's tail is on a collision course with Earth. Nothing to fear though: The tiny specks all burn up high in our atmosphere, producing one of the year's more reliable meteor showers, the Eta Aquarids.

Unfortunately, the May 5 peak occurs just a few days after a full moon, which will interfere with the best predawn hours for observing. Normally, you could expect some 10 to 20 meteors an hour that streak across the sky at 40 miles a second (65 km/s). This year, you may be lucky if you see five an hour. The Eta Aquarids are noted for their high ratio of bright meteors, many leaving trains.



All illustrations by *Astronomy*: Elisabeth Rowan

provide a visual feast. Izar in Bootes the Herdsman, Mizar and Alcor in the Big Dipper asterism of Ursa Major, and Porrima in Virgo are some of the finest doubles around. They are also easy to see in small telescopes.

Buried in the chest of Hercules lies one of the finest globular clusters, the Hercules Cluster (M13). Also take a look at the more compact but equally attractive globular M92, which lies farther north in Hercules.

The dim constellation Ophiuchus lies south of Hercules. It holds three bright globulars: M10, M12, and M14. Ophiuchus should rank as the 13th constellation of the zodiac. The sun passes through the Serpent-bearer between November 30 and December 18.

For a number of years **Pluto** has been a resident in Ophiuchus. Finding Pluto presents a stiff challenge to observers. This year, however, Pluto lies very close to Zeta (ζ) Ophiuchi, which serves as a useful guide. The 2.6-magnitude star lies midway along the base of the kite-shaped constellation. On May 30/31, Pluto reaches opposition and shines at magnitude 13.7, its brightest of the year.

To find Pluto, you need at least an 8-inch scope. Start your search by centering Zeta in the eyepiece. Then move roughly 0.4° north and switch to high magnification. This should shift Zeta out of your field of view, useful because glare from the star will prevent you from seeing the planet. To identify which point is Pluto, use the detailed star map on page 75 that shows the planet's path.

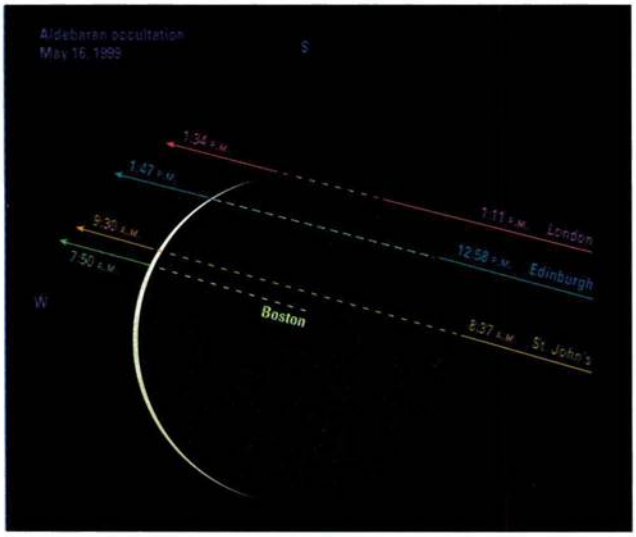
Another solar system interloper resides in this same area. Asteroid 3 Juno reaches opposition on May 25. In early May, Juno swings well to the north of Pluto and shines at magnitude 10.2. It ends the month lying roughly 1° away from Delta (δ) Ophiuchi. Tracking down Juno makes a good warm-up exercise for hunting Pluto.

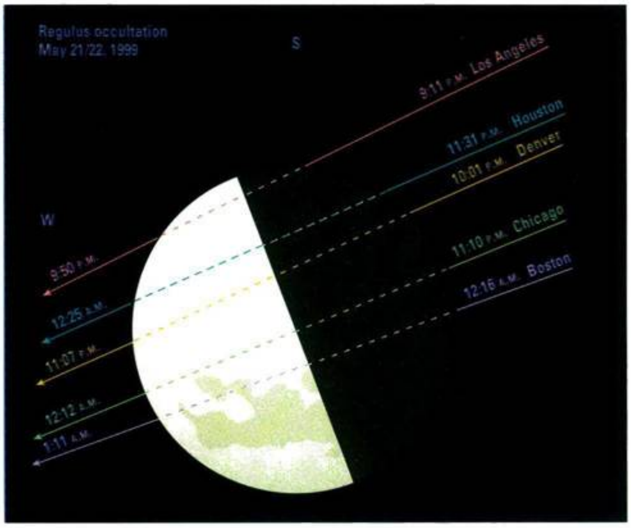
When Pluto crossed the orbit of **Neptune** this past February, Neptune was nowhere near that point in its orbit. Now Neptune continues to move slowly through Capricornus the Sea Goat. In fact, the planet's motion in right ascension comes to a halt as Neptune turns for its retrograde loop. This point is called its stationary point, and it occurs on May 6/7. At

The Moon Scores Twice

Just five days apart, the bright stars Aldebaran and Regulus get broadsided by the moon. The easiest of these two occultations to watch is the one occurring Friday night, May 21/22. This occultation of Regulus is visible to all North Americans. On the east coast, the event starts around midnight EDT, but on the west coast it's in twilight at 9 P.M. PDT. Observers wishing to capture useful scientific data from these events need only point a camcorder into the eyepiece.

The much more challenging of the two events happens during daylight hours of May 16 — it's a Sunday worth getting up early for. The very thin crescent moon will occult Aldebaran after daybreak for New Englanders and those in the Canadian Maritimes and near 1 P.M. local daylight time in the United Kingdom.


Aldebaran occultation
May 16, 1999
S
W
1:34 P.M.
1:47 P.M.
9:30 A.M.
7:50 A.M.
1:11 P.M. London
12:58 P.M. Edinburgh
Boston
8:37 A.M. St. John's


Regulus occultation
May 21/22, 1999
S
W
9:11 P.M. Los Angeles
11:31 P.M. Houston
10:01 P.M. Denver
11:10 P.M. Chicago
12:16 A.M. Boston
9:50 P.M.
12:25 A.M.
11:07 P.M.
12:12 A.M.
1:11 A.M.

To find Aldebaran, use a polar-aligned mount and offset from the sun by 1h04.5m east and 2°3' south. Take precautions to prevent sunlight from entering your telescope. You could severely damage your eyes by looking at the sun through a telescope without a filter.

For detailed times of the events for your observing site, as well as tips on how to record them, check out the website of the International Occultation Timing Association (http://www.sky.net/~robinson/iotandx.htm).

Venus Stands Tall

The beautiful evening star puts on a great show this month. It's obvious in twilight and blazes on well after twilight's end. In fact, at magnitude –4.2, Venus can cast a shadow.

To see your shadow by "Venuslight," wait until the gibbous moon is out of the evening sky, after May 4. You'll need to be in a very dark place with a good western horizon. Choose a site where the ground has a light color and face away from Venus. Make sure your eyes are dark adapted, then slowly sway your body back and forth. You should see a darker shape on the ground moving. That's your shadow as cast by Venus.

The planet's 60-percent-illuminated phase is significantly different than the crescent shape the moon has when it passes Venus on May 18. It's easy to understand why. Imagine being in a room with a single light bulb (the sun) at its center. You're standing at the 6 o'clock position, while Venus is at 10 o'clock. The planet's face is mostly lit. If you put the moon close to you and almost in the way of Venus, you'll see that the moon's face is just barely lit, or in a crescent phase.

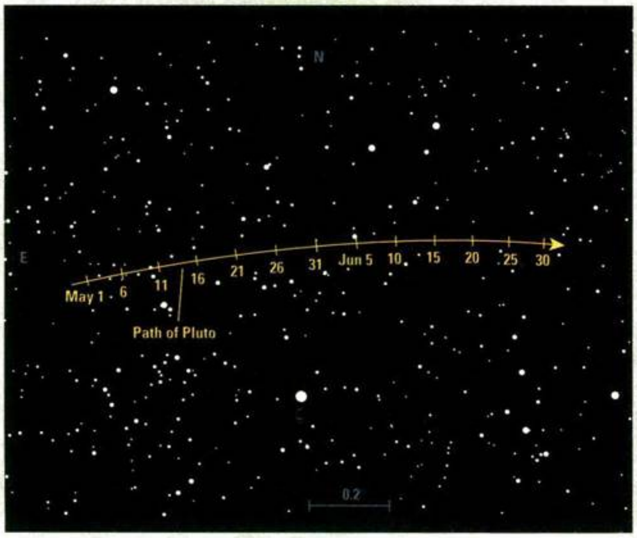
Randall Wehler

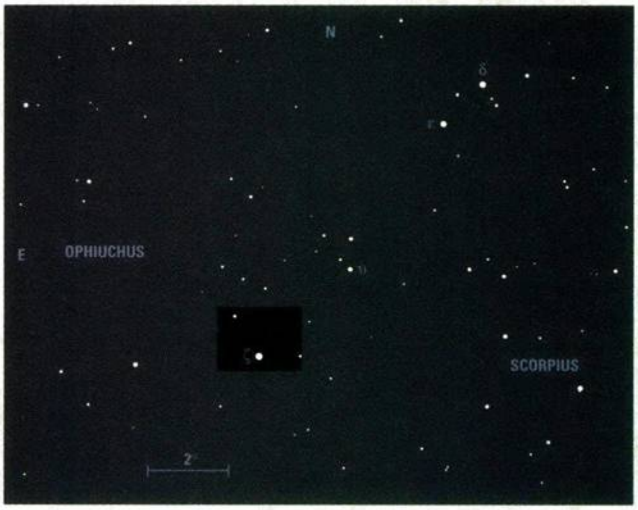
Observer's Challenge: Not So Difficult Pluto

If there's a year to easily find and track diminutive Pluto, this is it. Pluto spends all of May less than 1° (two moonwidths) from the bright star Zeta (ζ) Ophiuchi, which is better known as "the middle of the three bright stars lying along the base of Ophiuchus."

At magnitude 13.7, Pluto is generally not an easy target. A dark sky and an 8-inch telescope are typically considered necessary for success.

Hopping to Pluto is a snap. Start at 2.6-magnitude Zeta and shift ½° to the northeast. There you'll find an isosceles triangle of stars that spans roughly ¼°. The triangle is headed by an 8th-magnitude star. Flaring back toward Zeta are the two other 9th-magnitude stars. These three stars will act as reference posts to help you see Pluto's gradual displacement across the starfield.





Bigger telescopes usually invoke more confidence as to which faint "star" is a planet. The most instructive method of identification is to make a sketch of the field and then come back a night or two later to see which object has moved.

On May 8, Pluto inches 1' north of a 12.4-magnitude star. On May 10, it grazes a mere 9" south of an 11.6-magnitude field star.

This area of Ophiuchus is relatively devoid of stars that are of similar brightness to Pluto, so your chances of mistaking it are relatively slim — even more incentive to try for it this year.

about the same time, Neptune lies 0.4° south of the 5.2-magnitude star Pi (π) Capricorni — within the same low power field of view. Neptune's tiny bluish disk is some 10 times fainter at magnitude 7.9.

Uranus is brighter and lies just above a line that joins Iota (ι) and Theta (θ) Capricorni. Uranus can be picked up in binoculars easily enough once you have identified the correct field of view. Both of these stars shine near 4th magnitude, while Uranus is dimmer at magnitude 5.8. However, no other stars of comparable magnitude lie along the line that joins the pair of brighter stars, so identification should be fairly easy. Uranus reaches its stationary point on May 21/22. Uranus and Neptune rise around midnight and will reach opposition within two weeks of one another in late July (Neptune) and early August (Uranus).

As dawn approaches, **Jupiter** can be found low in the eastern sky. It undergoes a close conjunction with **Mercury** on May 1. The innermost planet shines at a respectable magnitude of –0.1, but is still six times fainter than –2.1-magnitude Jupiter. Mercury passes 1.7° south of Jupiter during the first two days of the month. Viewing will be difficult because the event occurs in a bright dawn sky with Mercury only 3° above the horizon 30 minutes before the sun rises. Jupiter itself continues to pull away from the sun's glow. It lies fairly high in the east in the predawn hours at month's end and rises more than two hours before the sun. Jupiter reaches perihelion on May 20, when it lies 4.9505 astronomical units from the sun (1 AU = 92,955,807 miles).

Mercury falls toward the sun, passing **Saturn** as it does. On May 13, the two lie 0.7° from each other and only 14° from the sun. This is the first of four conjunctions between Mercury and Saturn during the next four years. At the time of the twosome's meeting, Mercury shines at magnitude –0.9 and Saturn will be at magnitude 0.3.

By the end of May, Saturn rises more than an hour before the sun, joining Jupiter as the two biggest planets in the solar system return to the night sky. ■

Martin Ratcliffe is Director of Theaters at the Exploration Place in Wichita, Kansas. Alister Ling is a meteorologist working for Environment Canada in Alberta.

ALL TELESCOPES IN STOCK!

focus Camera & Video

24-HOUR FAX LINE
800-TO-FOCUS
OVERSEAS FAX LINE
718-437-8811
CUSTOMER SERVICE
718-437-8899

4419-21 13TH AVE. BROOKLYN, N.Y. 11219

BINOCULARS

CELESTRON

10x50 Regal	CALL	7x50 Ultima	CALL
8x32 Ultima	CALL	8x56 Ultima	269
9x63 Ultima	CALL	20x80 Giant	CALL

BLOWOUT!

10x42 Ultima	$129.99
8x40 Pro	$114.99
How To Choose Binoculars	6.95

MEADE

8x25 Safari Pro	180	10x25 Safari Pro	200
7x36 WA Safari Pro	170	8x42 WA Safari Pro	180
10x42 Safari Pro	190	10x50 WA Safari Pro	200
7x42 WA Rainforest Pro	480	8x56 Rainforest Pro	500

Nikon. SPORT OPTICS

You'll Never See Things Quite The Same Again!

7x35 E 245 8x30 E	256.95	10x70	1048.95
8x32 E Superior	468.95	7x50 Prostar	721.95
10x42 E Superior	588.95	10x40 Lookout IV	102.50
12x50 E Superior	649.95	10-22x50 Scoutmaster XL	150

SPOTTING SCOPES

Fieldscope (60mm)	358.95	Angled (60mm)	438.95
Fieldscope 60 ED II	574.95	60 ED II Angled	634.95
Fieldscope 78 ED	999.95	78 ED Angled	1069.90

BAUSCH & LOMB BUSHNELL

7x24 Elite	CALL	10x40 Custom	299
8x42 Elite	CALL	7x42 Discoverer	329
10x42 Elite	CALL	10x42 Discoverer	359

SPOTTING SCOPES

Discoverer 15-60x			172.95
Discoverer T-Mount	11.95	Camera Adapter	14.95
Spacemaster	149.95	Kit	247.95
Spacemaster Armored	163.95	Kit	259.95
Spacemaster Zoom Black Armored			226.95

All Kits Include: 15-45x Eyepiece & Case or Pouch

FUJINON

8x30 FMT-RSX	CALL	10x70 FMT-SX w/Case	CALL
7x50 FMT-SX w/Case	CALL	16x70 FMT-SX w/Case	CALL
SPECIAL! 7x50 FMTRC-SX w/Compass			459.95
7x42 DCF Slim Style	CALL	7-21x40 ZCF Roof Prism	CALL
Super 80 Scope w/Case			CALL

ZEISS

Special! 15x60	$1999.00
20x60 Image Stabilizer	CALL
Spotting Scopes	CALL

Canon

IMAGE STABILIZERS

10x30 IS	CALL
12x36 IS	CALL
15x45 IS	CALL

Leica

SPOTTING SCOPES
APO TELEVID 77mm
Ask About Leica
Passport Protection

SWAROVSKI OPTIK

SPOTTING SCOPES
CT-75 • CT-85
AT-80 • ST-80
AT-80 HD • ST-80 HD

TELRAD

Finder Scope $36.49

MEADE ADVANCED PRODUCTS

MAKSUTOV-CASSEGRAINS

NEW! **ETX-90/EC** *EXQUISITE, DIFFRACTION-LIMITED IMAGING IN AN ADVANCED, ULTRA PORTABLE TELESCOPE SYSTEM!*

Already **THE LARGEST-SELLING MODERN TELESCOPE** in the world, the Meade ETX has been reengineered for 1999 to provide the very latest in microprocessor-controlled capability.

NEW!
DELUXE ETX
FIELD TRIPOD
$199.00

Includes: Dual-Axis Drive, 8x21 Erect Image Viewfinder & 26mm Plossl

PUSHBUTTON ELECTRONIC HAND CONTROLLER Use the hand controller at any of four dual-axis speeds: 8x for image centering in the main telescope at high power; 32x for image centering at lower power or pushbutton object-tracking in the altazimuth mode; 0.75°/sec for image centering in the viewfinder or for terrestrial tracking; 5°/sec for fast slewing across the sky.

OPTIONAL AUTOSTAR CAPABILITY Plug in the Meade Autostar computer controller **(#497 only $149)** for LX200-type operation, including automatic GO TO capability to more than 12,000 celestial objects.

ETX 90/EC 1250mm f/13.8	$595.00
#880 Equatorial Table Tripod	29.95
#825 8x25 Right-Angle Viewfinder	49.95
#774 Hard Carry Case	99.95
#932 45° Erecting Prism	49.95
#64 Photo Adapter	34.95
#1244 Electric Focuser, Plugs into Control Panel	119.95
LX-50 7" f/15 w/Std Equatorial Wedge	$1,795.00
LX-200 7" f/15 w/Heavy Duty Fork Mnt	$3,295.00

SCHMIDT-CASSEGRAINS

LX-10 8" w/Hand Controller	$995.00
LX-50 8" f/10	$1,395.00
LX-50 10" f/10	$1,695.00
LX-50 10" f/10 w/Super Wedge	$1,895.00
LXD 500 SERIES 203 8" f/10	$1,295.00
LX-200 8"	$2,795.00
LX-200 10"	$3,195.00
LX-200 12"	$4,495.00
LX-200 16"	CALL
LX-200SC 12" f/2.2 Schmidt-Camera	CALL

PICTOR SERIES CCD IMAGES

201-XT Autoguider/Imager	395	208-XT Autoguider/Imager	495
216-XT Autoguider/Imager	695	Off Axis Guider f/CCD	115
416-XT Autoguider/Imager ***w/Free $800 Upgrade***			1,695
1616-XT Autoguider/Imager ***w/Free $800 Upgrade***			5,495
616 Color Filter System f/416, 1616-XT			695
616A Color Filter System f/216	695	542 AC Adapter f/416, 1616	98.95
541 AC Adapter f/201, 208, 216			36.95
520 Electronic Relay f/201, 208, 216, 416, 1616			98.95

MAGELLAN I COMPUTER SYSTEMS

#2010, 2011, 2012 f/Dobs. & Equat.	295
#2014 f/LX-10	375

MAGELLAN II COMPUTER SYSTEMS

#2018 f/Equatorial 6", 8", 10"	495	#2019 f/Equatorial 16"	595
#2024 f/LX-50	495	Interface Cable f/LX-200	25
EPOCH 2000sk Sky Software 3.5" Disks	149	CD	179
EPOCH 2000ip Software 3.5" Disks			199

DOBSONIANS

STARFINDER 6" f/8	$349.00
STARFINDER 8" f/6	$449.00
STARFINDER 10" f/4.5	$599.00
STARFINDER 12" f/4.5	$895.00
STARFINDER 16" f/4.5	$1,195.00
Dobsonian Deluxe Accessory Package	$49.95

EQUATORIALS

STARFINDER 6" f/8 w/2" Focuser	$649.95
STARFINDER 8" f/6 w/2" Focuser	$749.95
STARFINDER 10" f/4.5 w/2" Focuser	$879.95
STARFINDER 16" f/4.5 w/2" Focuser	$2,695.00

ED APO REFRACTORS

NEW! **500 SERIES 102 Apochromatic** 4" f/9	$1,695.00
NEW! **500 SERIES 102 Achromatic** 4" f/9	$995.00
102ED 4" f/9 w/Mount, Tripod & Accessory	$2,795.00
127ED 5" f/9 w/Mount, Tripod & Accessory	$3,295.00
152ED 6" f/9 w/Mount, Tripod & Accessory	$4,995.00
178ED 7" f/9 w/Mount, Tripod & Accessory	$5,995.00
Optical Tube Only	CALL
1664 Electronic Drive	$349.00
1697 Computer Drive System	$750.00

REFRACTORS/REFLECTORS

227 60mm Altaz. *w/Free Star Locator Software!*	CALL
230 60mm Altaz.	CALL
285 60mm Equat.	CALL
290 60mm Equat. *w/Free Star Locator Software!*	CALL
390 90mm Altaz.	CALL
395 90mm Equat.	CALL
4500 Newtonian	CALL

EYEPIECES

MODIFIED APOCHROMATIC

9, 12, 25, 40mm 1.25"	37.95	9, 12, 25, 40mm .96"	32.95

PLOSSL SERIES 3000

5, 6.7, 9.5, 16, 25mm 1.25"	49.95	40mm 1.25"	79.95

PLOSSL SERIES 4000

6.4, 9.7, 12.4, 15, 20, 26mm 1.25"			79.95
32, 40mm 1.25"	99.95	56mm 2"	199.95

PLOSSL SERIES 4000 SUPER WIDE ANGLE

13.8mm 1.25"	139.95	18mm 1.25"	149.95		
24.5mm 1.25"	179.95	32mm 2"	239.95	40mm 2"	299.95

PLOSSL SERIES 4000 ULTRA WIDE ANGLE

4.7mm 1.25"	169.95	8.8mm 1.25"/2"	239.95
6.7mm 1.25"	199.95	14mm 1.25"/2"	299.95

ILLUMINATED RETICLE EYEPIECE SYSTEMS

Plossl 9mm 1.25" wireless	149.95	MA 12mm 1.25" wireless	99.95
Plossl 9mm 1.25" w/cord	129.95	MA 12mm 1.25" w/cord	79.95

BARLOWS

#122 2x Telenegative 1.25"	44.95	**#127** 2x-3x Variable 1.25"	56.95
#126 2x Short Focus 1.25"	44.95	**#134** Achromatic .96"	44.95
#140 2x Apochromatic 1.25"			71.95

ACCESSORIES

#62 T-Adapter f/SCT	26.95	#931 45° Hybrid Erect Prism	42.95
Off Axis Guider	79.95	607 25' Cigarette Adapter	24.95
f/6.3 Focal Reducer	129.95	55 Manual DEC Control	74.95
Basic Tele-Extender	29.95	#1205, 1206, 1207 Focuser	CALL
Variable Tele-Extender	39.95	6x30, 8x50 Viewfinder	CALL
Camera Adapter 1.25"	29.95	Piggyback Bracket f/SCT	CALL
Camera Adapter .96"	27.95	Dew Shields & Dust Covers	CALL
Variable Projection Camera Adapter 1.25"			39.95
#927 45° Erect Image Diagonal Prism .96"			42.95
#928 45° Erect Image Diagonal Prism 1.25"			42.95
#929, #930 2" Mirror Diagonal w/Eyepiece Holder f/1.25"			99.95
Tube Balance Weight System f/All SCT			CALL
531 Motor Drive e/Auto Tracking f/4500 Newtonian			CALL

FILTERS

4 Piece Set 1.25"	49.95	Moon Filter ND96 1.25"	19.95
Individual Filter	14.95	Skylight/Dust Seal	44.95
#905 Variable Polarizer 1.25"			49.95
908 Broadband Nebular 1.25"			79.95
910 Broadband Nebular 2"			119.95
911 Broadband Nebular Rear Cell			99.95
908 Narrowband Nebular 1.25"			89.95
910 Narrowband Nebular 2"			129.95
911 Narrowband Nebular Rear Cell			119.95

JMI JIM'S MOBILE INC.

Next Generation Computers
Motofocus • NGF Focuser
Wheely Bars • Motodec

THOUSAND OAKS

Precision Glass Solar Filters
Mounted Type 2
Mounted Type 2 Plus
Mounted Type 3 Plus

Kowa

77MM SERIES SPOTTING SCOPES

TSN-2	379.95	TSN-3	799.95

TSN-4 . . . $699.95

82MM SERIES WATERPROOF SPOTTING SCOPES

TSN-821 Angled	399.95	TSN-823 Angled	899.50
TSN-822 Straight	364.50	TSN-824 Straight	869.95

CHECK OUT OUR SPECIAL PACKAGE PRICING ON 820 SERIES SPOTTING SCOPES!

Package includes: Scope, 20-60x, Case & Tripod.

IF YOU DON'T SEE WHAT YOU WANT... JUST ASK! WE HAVE EVERYTHING TO HELP YOU REACH THE STARS!

MEADE MONTHLY SPECIALS

97E2 Spotting Scope	$399.95
223 60mm Altazimuth *w/Free Star Locator Software!*	$79.95
2045s Spotting Scope	$419.95
LX-200 8" f/6.3	CALL
MTS-SN6 Telescope	CALL

Focus Camera, Inc., 4419-21 13th Ave., Brooklyn, NY 11219 ALL ORDERS ARE SUBJECT TO AVAILABILITY AND VERIFICATION. ORDERS ONLY CALL 800-221-0828 • INFORMATION & NY STATE CALL (718)437-8810 Orders ORDER STATUS & CUSTOMER SERVICE (718) 437-8899 • 24-HOUR FAX LINE (718) 437-8810 • STORE INQUIRIES (718) 436-6262. Shipped Promptly - Most Major Credit cards, Money orders & personal checks accepted for payment. COD orders are accepted but may require a deposit, personal checks may require up to

INFORMATION & N.Y. STATE ORDERS
718-437-8810
E-MAIL
orders@focuscamera.com

VISIT OUR WEBSITE FOR DAILY SPECIALS & UPDATES www.focuscamera.com

800-221-0828

CELESTRON

SCHMIDT-CASSEGRAINS

C5+

For astronomy on the go, the C5+ can't be beat. Due to its excellent Schmidt-Cassegrain design and careful crafting, the telescope is a serious, high performance instrument, and its compact size makes it totally portable. The total weight of the C5+, with wedge, is just 23lbs., making it easy to transport.

The C5+ is made in the USA and features Celestron's legendary hand-figured, diffraction limited optical system for optical performance you can depend on. The reputation for excellence of this telescope is such that it was chosen by NASA, over all other competitive models, for several recent space shuttle missions.

C5+ 5", 1250mm f/10	CALL *	
ULTIMA 2000 8" 2032mm f/10		
2032mm f/10 w/Go To System	CALL *	
ULTIMA 9 1/4 9 ¼", 2350mm f/10	CALL *	
Ultima 11 11", 2800mm f/10	CALL *	
CG 9 1/4 w/Losmandy Mount	CALL *	
CM-1100 11", 2800mm f/10	CALL *	
CM-1400 14", 3910mm f/11	CALL *	
G-3 3.5", 1000mm f/11	**NEW!**	$499.00
G-5 5", 1250mm f/10	**NEW!**	$689.00
G-8 8", 2032mm f/10	**NEW!**	$999.00

CELESTAR 8 COMPUTERIZED

Engineered for unsurpassed optical performance in an affordable, full featured Schmidt-Cassegrain telescope of large enough apeture to do serious deep-sky observing. This telescope is carefully crafted and manufactured in the USA for dependable quality of the highest caliber. It offers the lowest price ever for a Celestron fork mounted 8" telescope.

The Celestar 8 Computerized comes with factory installed and tested Advanced Astro Master. The Advanced Astro Master pointing system contains a database of over 10,000 objects. Once aligned, it will guide you to any one of these objects.

CELESTAR 8 8", 2032mm f/10	CALL **
CELESTAR 8 COMPUTERIZED	CALL **
CELESTAR 8 DELUXE	CALL **
CELESTAR 8 DLX COMP.	CALL **

* **FREE! 2x BARLOW W/PURCHASE**

STAR HOPPER DOBSONIAN

4.5"	CALL	11"	CALL
6"	CALL	14"	CALL
8"	CALL	17.5"	CALL

FREE GIFT WITH DOBSONIAN PURCHASE!

ACCESSORY PACKAGE KITS

KIT #1 Includes: 5x24 Finderscope, 10mm SMA Eyepiece, Moon Filter & *"The Sky for Celestron"* CD-ROM	CALL
KIT #2 Includes: 6x30 Finderscope, 10mm SMA Eyepiece, Moon Filter, LED Flashlight & Celestron Sky Maps	CALL
KIT #3 Includes: 9x50 Finderscope, 7.5mm & 17mm Plossl Eyepiece, Moon Filter, Night Vision Flashlight & *"The Sky for Celestron"* CD-ROM	CALL

NEWTONIAN TELESCOPES

Firstscope 76 Series 76mm (3")	CALL **
Firstscope 114 Series 114mm (4.5")	CALL **
C114-HD 114mm (4.5"), 900mm f/8	CALL **
C150-HD 150mm (6"), 1000mm f/7	CALL **

REFRACTOR TELESCOPES

Firstscope 80 Series 80mm (3.1")	CALL **
Firstscope 70 Series 70mm (2.8")	CALL **
Firstscope 60 Series 60mm (2.4")	CALL **
C80-HD 80mm (3.1"), 900mm f/11	CALL **
C102-AZ or HD 102mm (4"), 1000mm f/10	CALL **

SPOTTING SCOPES

C5 Spotter w/Free T-Mount	CALL
Ultima 80	$349.00
Rich Field 80	$299.00
60mm Zoom	CALL
50mm Zoom	CALL
30mm Mini Spotter	$79.00

TRIPODS & MOUNTS

Lightweight Field Tripod (93591-A)			179
Photographic Slow Motion Control			26.95
Photographic Slow Motion Control Deluxe			57.95
Photographic Tripod (93596)	99.95	Vibration Supression Pads	39.95
Heavy Duty Wedge (93655)	239.95	Upgrade Kit f/93655	114.95

ASTRO/CCD PHOTOGRAPHY

CCD Camera PixCel	CALL	Piggyback Mount 8" & 9 1/4"	34.95
CCD Color Filter Wheel	364.95	Radial Guider	98
Digital Setting Circles	CALL	Reducer/Corrector f/6.3	112
Piggyback Counterpoise f/C5	59.95	T-Adapter	CALL

ACCESSORIES

AC Adapter	18.95	Car Battery Adapter	19.95
Case f/C5 & C8 (Most Models)	174	Lens Shades	CALL
Counterweight Bar Assembly 8"	89.95	11"	94.95
DEC Motor f/C5+, Celestar 8, Ultima 9 1/4/11			CALL
Flashlight Red Astro Lite	9.95	Focus Motor	114.95
Flashlight LED	18.95	Motor Drives	CALL
Focus Micrometer, Digital	109.95	Solar Filters	CALL
Hand Controller f/C+, Celestar 8			49.95

FINDERSCOPES

5x24	23.50	7x50 Polaris	104.95
6x30	39.95	6x30 LER	42.95

FILTERS

4 Piece Filter Sets	49.95	Moon Filter	19.95	Skylight Filter	44.95
LPR Filter Model B f/Back Threads of SC's					84.95
Polarizing Filter Set 1.25"	42.95	LPR Filter Model A 1.25"			59.95

EYEPIECES & VIEWING ACCESSORIES

Barlow 2x 1.25"	44.95	Barlow 2x .96"	19.95
Barlow 2x 1.25 Ultima	CALL	Barlow 2x .96" Dlx	43.95
Diagonal, Erect Image 45°	39.95	Diagonal, Prism Star	39.95
Diagonal, Erect Image 90°	49.95	Diagonal, Mirror 2"	134.95
Plossl 32, 40mm	57.95	Tele-Extender Dlx	48.95
Plossl 6.3, 7.5, 10, 12.5, 17, 20, 26mm			44
Ultima 1.25" 35, 40mm	104.95	Ultima 1.25" 18, 24, 30mm	84.95
Ultima 1.25" 5, 7.5, 12.5mm			74.95

LV SERIES 1.25"

2.5mm	127	6mm	112	12mm	115	20mm	125
4mm	117	9mm	109	15mm	115	25mm	125
5mm	109	10mm	109	8-24mm Zoom			169

RG-240 by L-5 Systems

L-5 Systems announces the start of production of their new 24" telescope, the RG-240. It is a quantum leap ahead of the older JC-524. The design of the split-ring mount and mirror cell has not changed with the exception of heavy-duty stepper motors, planetary gear heads, and a 16.5" spring-loaded worm-and-dec. gear. The truss system and upper portion has been totally re-engineered with two separate focusers on either side of the optical tube. The secondary mirror assembly rotates 180 degrees to accommodate this system.

$25,000
(Shipping & Crating Additional)

TeleVue
"Tops In The Field"

Pronto™

w/1.25", 45° Erecting Prism & 20mm Plossl	$925.00
w/1.25" Mirror Diagonal & 20mm Plossl	$945.00
w/2" Mirror Diagonal & 20mm Plossl	$1085.00

Ranger

70mm ED SCOPE
Available in Ivory, Green or Brass
MANY PACKAGES AVAILABLE!

101 (Green or Ivory)	$2760.00
TV-85 (Green or Ivory)	$1995.00

EYEPIECES & BARLOWS

ZOOM EYEPICE 8mm-24mm $210.00

PLOSSL (50°)		NAGLER (82°)		PANOPTIC (68°)	
8mm 1.25"	82.00	4.8mm 1.25"	175.00	15mm 1.25"	210.00
11mm 1.25"	82.00	7mm 1.25"	220.00	19mm 1.25"	240.00
15mm 1.25"	82.00	9mm 2"/1.25"	240.00	22mm 2"/1.25"	280.00
20mm 1.25"	95.00	***NEW!* RADIAN (60°)**		27mm 2"	330.00
25mm 1.25"	95.00	3mm 1.25"	228.00	35mm 2"	365.00
32mm 1.25"	110.00	4mm 1.25"	228.00	Barlow Interface	90.00
40mm 1.25"	110.00	5mm 1.25	228.00	**BARLOWS**	
55mm 2"/1.25"	230.00	6mm 1.25"	228.00	2x 1.25"	105.00
NAGLER Type 2 (82°)		8mm 1.25"	228.00	3x 1.25"	105.00
12mm 2"/1.25"	285.00	10mm 1.25"	228.00	2x Big 2"	168.00
16mm 2"/1.25"	310.00	12mm 1.25"	228.00	2.5x Powermate	168.00
20mm 2"	395.00	14mm 1.25"	228.00	5x Powermate	168.00

MOUNTS

TELE-POD MOUNT Complete 7 lb mounting system. *Ideal for traveling!*	$310.00
Ash Panoramic Mount	$390.00
Ash Gibraltar Mount	$530.00
Ash Gibraltar & Sky Tour	$1320.00

ACCESSORIES

RICH FIELD KIT Includes: 55mm Plossl, 2" Star Diagonal, SCT to 2" E.P. Adptr & 2" to 1.25" E.P. Adptr	$410.00
RICH FIELD PREMIUM KIT w/Premium 2" Star Diag.	$480.00
Bino Vue Binocular Viewer	$1030.00
Paracorr Photo/Visual 2" Coma Corrector	$235.00
NEW! Premium 2" Star Diagonal Mirror	$255.00
2" Star Diagonal Mirror	$190.00
1.25" Star Diagonal Mirror	$75.00
1.25" Erecting Prism 45°	$60.00
Basic Qwik Point	$18.00
Starbeam Projection Finder	$180.00
Camera Adapter 1.25" & 2"	$36.00
Piggy-Cam Camera Adapter	$42.00

CELESTRON MONTHLY SPECIALS

PixCel CCD CAMERA	$895.00
GP-C8 Mount w/Wood Pod (Demo) #91514-GP	CALL
FASTAR 8 2032mm (8"), f/10	$2,089.00
Skyscope 114 (Demo)	CALL
GPC-102 ED 102mm (4"), 920mm f/9	$1,999.95
500mm Mirror Lens #81005	$239.95

CELESTRON MONTHLY SPECIALS

C90 MULTICOATED OUTFIT

WITH FREE T-MOUNT!

#81011

$349.95

Take advantage of our *LARGE INVENTORY!* Immediate shipment from stock!

14 days to clear. All orders are subject to verification & acceptance. Shipping, handling & insurance are additional,please call/write for exact details. 14-day money-back guarantee (less shipping) provided merchandise is returned in new condition, unused as received with papers & packaging intact. We gladly accept and reply to written or faxed inquiries. Ad prices available while supplies last. This ad supersedes all previous ads. Focus camera is not responsible for typographical errors. Hours: Mon.-Thurs. 9-7, Fri. 9-2, Sun. 10-6.

Spirals and Giants

and Dwarfs oh my!

Fearlessly tracking down faint galaxies brings rewards of clusters, mergers, and fuzzy wisps.

by Steve Gottlieb and Richard Jakiel

Photographs of galaxies, such as those gracing this magazine, show some of the most beautiful and intriguing objects in the universe. The majestic whorls of spirals, the vast gatherings of distant clusters, and the vivid chaos in the cores of merging pairs invoke a certain awe stirred by the natural wonder of the scene.

They may also invoke feelings of intimidation, especially if you long to observe the galaxies through a telescope. But you needn't fear the dark unknown. Embarking on a tour of galaxies and galaxy clusters can become a meaningful journey. A well-trained eye can pick up structural details and delicate features often taken for granted in photographs. And knowing that the dim, diffuse light at the edge of perception is really a dynamic system of tens of billions of stars will tug at your notion of existence.

To prepare, pick up a good sky atlas such as *Uranometria 2000.0* by Wil Tirion, Barry Rappaport, and George Lovi (Willmann-Bell, Inc.) or *Sky Atlas 2000.0* by Wil Tirion (Cambridge University Press). Then, consider employing a few techniques that will help your eyes gather every precious photon. Practice using averted vision and wear a dark hood over your head at the eyepiece to block extraneous light. Use moderate magnifications of 10x to 15x per inch of aperture to help you discern subtle details. And try your hand at sketching. Not only will it greatly improve your ability in seeing low contrast detail, but you'll have a permanent record of your observations.

Now, let's begin our tour of the spring sky. We'll start at the great spirals and the giant ellipticals, followed by those objects obstructed by the dust and stars of our own galaxy. Finally, we'll briefly tour two enormous aggregations of galaxies — the Coma and Hercules clusters.

IC 10 by Bonn Observatory

Celestial Pinwheels

When observing galaxies, you can divvy them up the way Edwin Hubble did. In 1926, he devised a scheme for categorizing normal spirals into three main groups: Sa, Sb, and Sc. Sa spirals have well-developed central regions surrounded by tightly bound spiral arms. Sb, or intermediate, spirals have broader, fainter cores and arms. Wide open spiral arms punctuated by bright HII knots dominate Sc spirals.

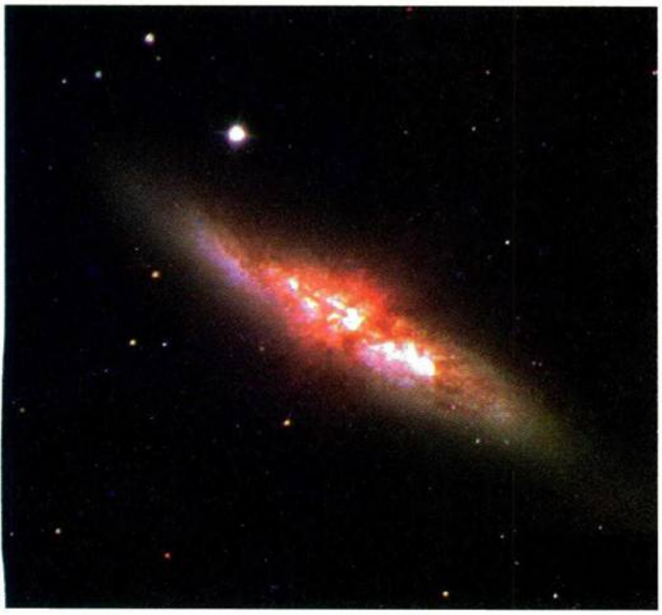
Let's follow the progression starting with the Sa spiral M104 (NGC 4594), known as the **Sombrero Galaxy**. From the bright star Spica in Virgo, move 4.5° east to see this classic edge-on galaxy. It derives its name from the hefty central bulge, the tapering 8' extensions that make up the brim, and a prominent dust lane that bisects the entire galaxy.

For a good look at an Sb galaxy, check out our nearest spiral neighbor, M31 (NGC 224), the **Andromeda Galaxy**. You can detect its soft, elongated glow by following a line northwest from 2nd-magnitude Mirach (Beta [β] Andromedae) through 4th-magnitude Mu (μ) And. In an 8-inch telescope, the most impressive feature may be the prominent jet-black dust lanes that skirt the galaxy's core. But you don't need a scope to enjoy this beauty. At 2.2 million light-years away, M31 is the most distant object visible to the naked eye.

Linger near M31 a bit and check out **NGC 206**, a huge cloud of young, massive stars located along the southwest periphery of the galaxy, about 40' from the core. The combined light from these stars is faintly visible in a 6- to 8-inch scope. Users of 16-inch scopes and larger can challenge themselves by picking out the numerous 15th-magnitude globular clusters orbiting M31. They look like faint stars, so you'll need a detailed finder chart to pinpoint them.

The brightest springtime Sb galaxy is **M81** (NGC 3031) in Ursa Major. A small telescope shows it as a striking ellipse with a bright core. In a 17.5-inch scope, the view reveals a winding spiral arm on the south side of the galaxy and another arm just visible as a short extension hooking around the north end toward a 12th-magnitude star.

Just 38' north of M81 lies **M82** (NGC 3034), an eruptive starburst galaxy. In 6- to 8-inch telescopes at 100x, it draws your attention. Several dark lanes mottle the high surface spindle at an oblique angle to the major axis. Photographs reveal a tortured disk once thought to be exploding, but now explained by bursts of star formation in M82's nucleus.



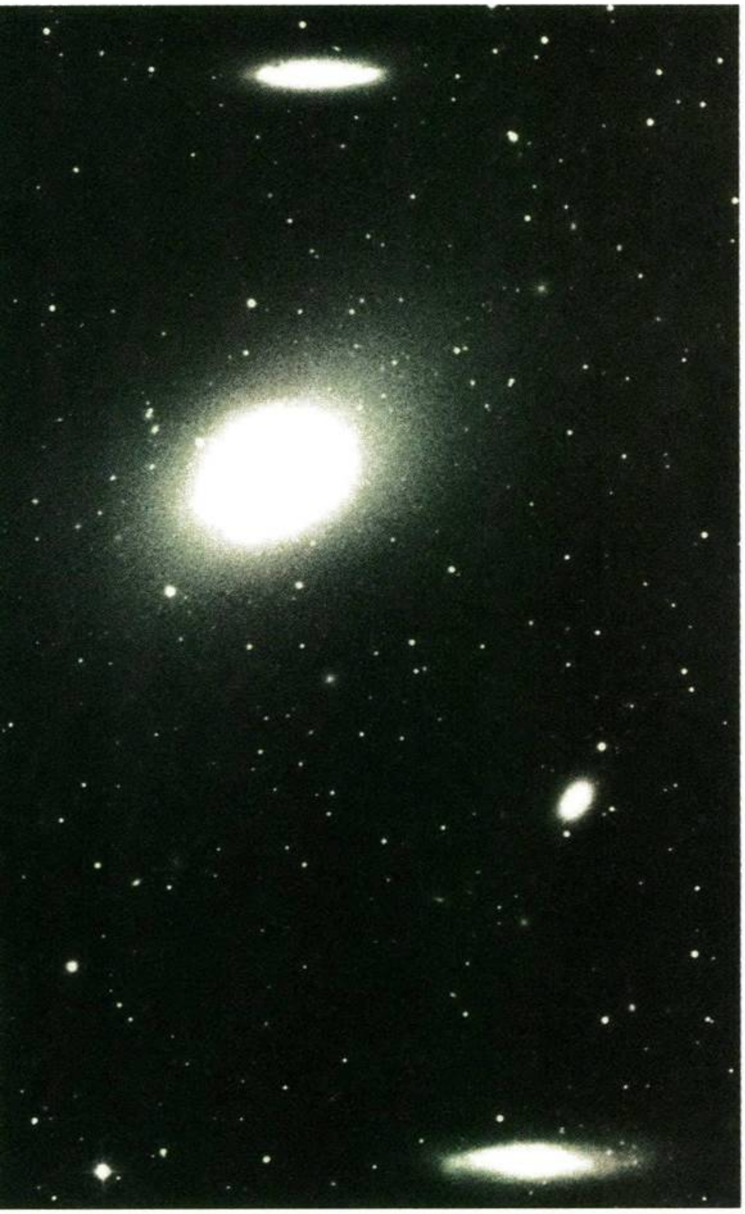
Bonn Observatory

Finally, for a springtime view of an Sc spiral, visit **M83** (NGC 5236) in Hydra. Long-exposure photographs and CCD images reveal massive spiral arms peppered with huge star clouds and HII regions. A moderate-sized scope under dark skies shows the bright central region's elongated bar, which has subtle spiral arms that arc around the core forming a cosmic Greek letter Theta (θ). Northern observers should not disregard this southerly galaxy, which ranks among the ten brightest in the sky.

Of all the galaxies in the night sky, spirals appear most abundant, but don't overlook the giant ellipticals.

Hungry Giants

Sparse in numbers, giant elliptical galaxies often span great distances of sky. They can extend more than several hundred thousand light-years, considerably larger than the largest spiral. Older, reddish stars typically dominate their color, and their extreme mass often wreaks havoc on their smaller neighbors.



Martin Germano

Left: The center of the spiral galaxy M82 erupts into a fit of newborn stars as it gets tugged gravitationally by nearby M81 (not shown). Above: Hungry elliptical M86 lurks at the center of the Virgo Cluster, where it stalks its smaller neighbors. At the far upper left of the image, NGC 4435 whizzes over NGC 4438, stripping away stars and gas. Right: This infrared image of the Maffei I shows detail not typically seen in visible light because dust from our own Milky Way obscures the light coming from this elliptical giant.

One of the closest giant ellipticals is NGC 5128, also known as **Centaurus A**. This 7th-magnitude system lies just 7° north of the bright globular cluster Omega Centauri. The object's most striking feature is the broad dust lane slashing through its center. This lane is actually the remnants of a spiral galaxy consumed by the massive elliptical about a billion years ago. Observers with large scopes can discern intricate structural details under moderate magnification.

Other hungry giants can be found near the core of the Virgo Cluster. Here, **M84** (NGC 4374) and **M86** (NGC 4406) form a pair of 10th-magnitude "eyes" in a galactic "smiley face." The nearby edge-on spirals, **NGC 4402** and **NGC 4388**, show evidence that they have lost some of their gas and dust to their massive neighbors. You can view both the big ellipticals and the smaller spirals in the same low-power field.

Much more spectacular is **M87** (NGC 4486), an angry giant that has consumed a number of its brethren. Even the smallest instruments will resolve the galaxy's bright core and slightly oval halo. For a challenge, use a moderate-sized scope with a CCD camera to see the optical jet discovered by H. D. Curtis in 1918. Look for the low-contrast, narrow wisp to the east-northeast of the core.

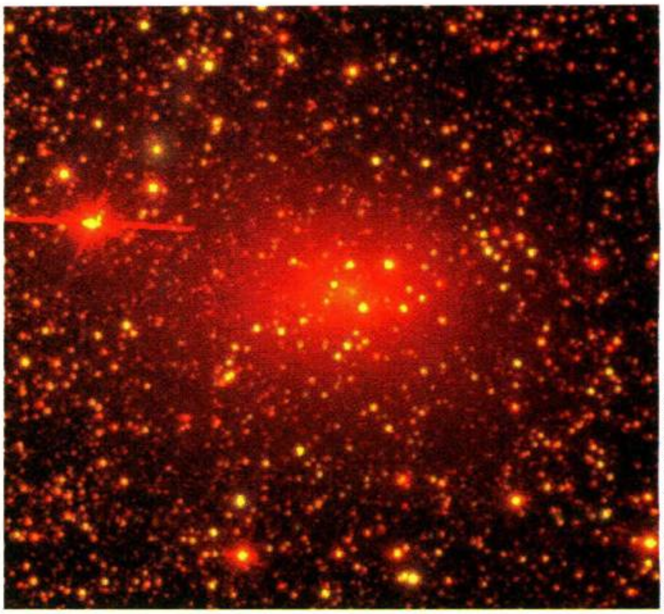
Even M87 pales in comparison with the largest of the ellipticals, the cD galaxy. Named for their immense, extended halos, these reign as the undisputed lords of the realm. Perhaps the most famous is **NGC 6166**, a spectacular giant located in the constellation Hercules. It dominates the galaxy cluster Abell 2199 and has at least four nuclei, three of which are remnants of other galaxies. An 8- or 10-inch scope will reveal an oval, diffuse glow with a mottled central region, even though it lies almost 600 million light-years away. Larger scopes may reveal some of the nearly stellar nuclei plus a faint swarm of attendant galaxies.

Merging Mania

Giant ellipticals are not the only ones producing catastrophe in the universe. Collisions often occur between spiral galaxies. The gravitational tug, called a tidal interaction, between spirals often results in some of the most fantastic phenomena in the cosmos. Well-known colliding galaxies include the Whirlpool Galaxy (M51), the Antennae, and the Mice. Other galaxies, such as the Cartwheel and the Helix, are famous remnants long after the merger has taken place.

Begin at two galaxies on the verge of colliding: NGC 4490, the **Cocoon Galaxy**, and **NGC 4485** in Canes Venatici. Their cores lie a mere 4' apart, a distance of only 30,000 light-years. An 8-inch scope shows the unusual shape of the tidally distorted tip of NGC 4490, the larger of the two galaxies. The smaller NGC 4485 has an irregular, oval glow with a brighter core. Large backyard scopes will show an intricate play of dusty motes and bright knots in the more massive spiral.

The spectacular **Antennae**, or NGC 4038 and NGC 4039 in Corvus, make up one of the most unusual sights in the



William C. Keel, University of Alabama

night sky. Here, a pair of spirals dance in the earliest stages of merger. Tidal interactions have produced two curved tails spanning 20', more than 550,000 light-years long. The resulting mass looks like a warped shrimp with faint condensations occurring in two regions. Recent images with the HST show these areas as hotbeds of star formation.

Observing with an 8- or 10-inch scope will resolve the shrimp, but amateurs equipped with 16 to 20 inchers should see the brightest HII regions and hints of the tidal tails. And better yet, some Dobsonian users have reported seeing the full extent of the galactic creature's "antennae."

The last two objects are examples of merged systems. The first is **NGC 6240** in Ophiuchus, which, in HST images, looks like a lobster complete with claws. It's one of the largest known spiral galaxies. Widespread star formation spans the entire disk of the galaxy, which is visible in a medium-sized instrument as an oval, mottled disk and core. Sixteen-inch scopes or larger should reveal some hints of the claws.

Far to the north lies NGC 2685, the **Helix Galaxy** in Ursa Major, a fine example of a polar ring galaxy. Here, the collision and subsequent merger have taken place between 2 and 5 billion years ago, leaving a belt of gas and dust strewn at right angles to the long axis of the galaxy. Moderate scopes should resolve the the 11th-magnitude spindle shape of the main galaxy. The delicate polar ring is probably not visible in any telescope but would make a nifty challenge for the CCD-equipped amateur.

Behind the Veil

While scanning the springtime sky for galaxies, pause for a moment in the direction of the Milky Way's plane. Here, dust obscures and reddens objects, reducing visibility. Edwin Hubble called this band the zone of avoidance (ZOA). In recent years, however, infrared, radio, and x-ray studies have penetrated the ZOA. And scientists continue to learn more about the galaxies hidden behind the Milky Way's veil.

Research has revealed, for example, that **IC 10**, an irregular dwarf member of the local group, has recently undergone a period of vigorous star formation, qualifying it as a classic "starburst" galaxy. Located just 3.3° from the galactic plane in Cassiopeia, IC 10 is the closest starburst galaxy to the Milky Way. An 8-inch scope will reveal a hazy spot within a rich star field. In a 13-inch scope, the low surface brightness glow extends to 4' in diameter, elongated northwest-southeast. The appearance is unusual, with no visible core and a superimposed 13th-magnitude star.

In 1967, Italian astronomer Paulo Maffei accidentally discovered a heavily obscured galaxy on a near infrared photograph of IC 1805, a huge star-formation complex in Cassiopeia. At a distance of only 12 million light-years, **Maffei I** had escaped previous detection — its luminosity reduced five magnitudes by intervening dust. If not situated toward the ZOA, this giant elliptical would be one of the showpiece galaxies in the sky. Ferret out Maffei I from the surrounding Milky Way star field using a 13-inch or larger scope. Maffei I's core appears as a low-surface-brightness glow elongated east-west and sometimes mistaken for a small patch of galactic nebulosity.

Groups and Clusters

If you enjoy observing galaxies, why not view them in bunches? Crammed into a mere 4' is **Stephan's Quintet**, a favorite deep-sky target located 30' south-southwest of the bright galaxy NGC 7331. A 6- or 8-inch scope can resolve a couple of dim patches, but a clear view of the entire quintet will probably require a 12-inch scope and dark skies. The

Deep-Sky Objects in the Spring Sky

Object	R. A. (2000.0)	Dec.	Mag.	Size/Sep.	Type	Notes
IC 10	00h20.4m	+59° 18'	10.4	6.3 by 5.1	IBm	
M31	00h42.7m	+41° 16'	3.4	190.5 by 61.7	SA(s)b	
Maffei I	02h36.6m	+59° 39'	11.4	0.6 by 0.5	S0$^-$ pec:	
NGC 2685	08h55.6m	+58° 44'	11.3	4.5 by 2.3	(R)SB0$^+$ pec	Helix Galaxy
M81	09h55.6m	+69° 04'	6.9	26.9 by 14.1	SA(s)ab	
M82	09h55.9m	+69° 41'	8.4	11.2 by 4.3	I0	
NGC 4038	12h01.9m	-18° 52'	10.3	5.2 by 3.1	SB(s)m pec	Antennae
NGC 4039	12h01.9m	-18° 53'	10.6	3.1 by 1.6	SA(s)m pec	Antennae
M84	12h25.1m	+12° 53'	9.1	6.5 by 5.6	E1	Virgo Cluster
M86	12h26.2m	+12° 57'	8.9	8.9 by 5.8	E3	Virgo Cluster
NGC 4485	12h30.5m	+41° 42'	11.9	2.3 by 1.6	IB(s)m pec	
NGC 4490	12h30.6m	+41° 38'	9.8	6.3 by 3.1	SB(s)d pec	Cocoon Galaxy
M87	12h30.8m	+12° 24'	8.6	8.3 by 6.6	E$^+$0-1 pec	Virgo A
M104	12h40.0m	-11° 37'	8.0	8.7 by 3.5	SA(s)a	Sombrero Galaxy
NGC 4889	13h00.1m	+27° 59'	11.5	2.9 by 1.9	E$^+$4	Coma Cluster
NGC 5128	13h25.5m	-43° 01'	6.8	25.7 by 20.0	S0 pec	Centaurus A
M83	13h37.0m	-29° 52'	7.5	12.9 by 11.5	SAB(s)c	
NGC 6045	16h04.6m	+17° 43'	13.3	1.3 by 1.1	SB0^b	Hercules Cluster
NGC 6166	16h28.6m	+39° 33'	11.8	1.9 by 1.4	E$^+$2 pec	Abell 2199
NGC 6240	16h53.0m	+02° 24'	12.9	2.1 by 1.1	I0: pec	
NGC 7320	22h36.1m	+33° 57'	12.6	2.2 by 1.1	SA(s)d	Stephan's Quintet

Object: Designation in NGC or other catalog. **R.A. (2000.0) and Dec.:** Right ascension and declination in epoch 2000.0 coordinates. **Mag.:** Visual magnitude. **Size/Sep.:** Size in degrees, arcminutes, or arcseconds, separation in arcseconds.

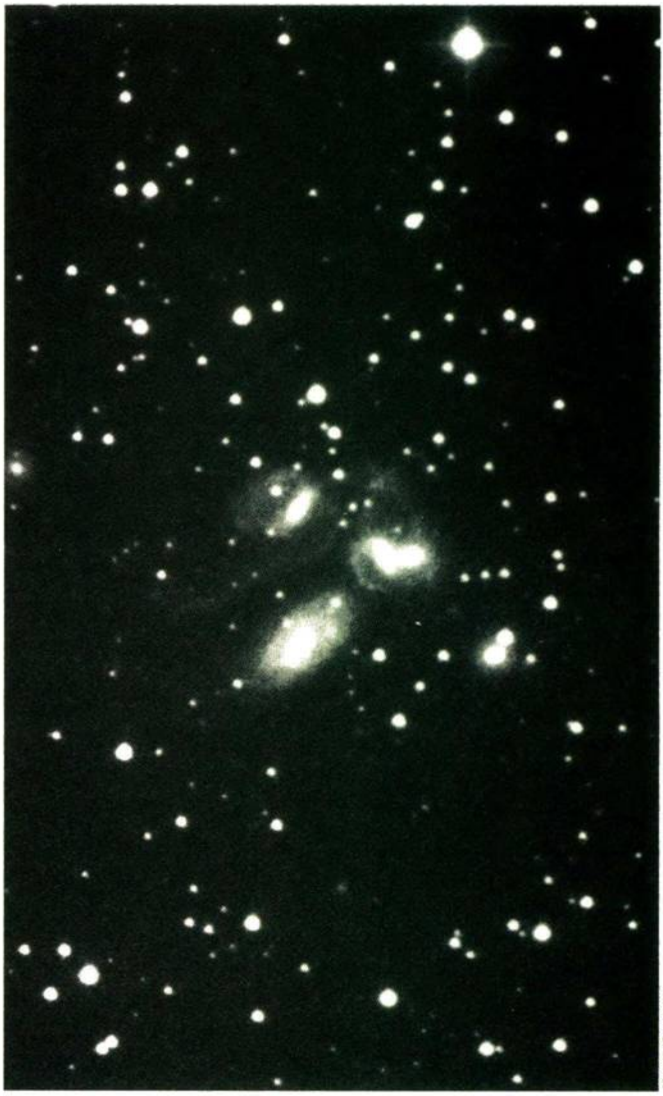
brightest member, NGC 7320, appears as a small, faint oval. Less than 2' northwest lies NGC 7318, a pair of intertwined spirals containing two stellar nuclei within a common halo.

Backyard telescopes have access to two well-studied clusters: the **Coma Cluster** (Abell 1656) and the **Hercules Cluster** (Abell 2151). The Coma Cluster is a rich, concentrated cloud of hundreds of galaxies about 350 million light-years away. A pair of supergiant cD galaxies, NGC 4874 and NGC 4889, dominate the cluster's core, attended by a retinue of dwarf ellipticals and lenticulars. Over time, a hot intracluster medium glowing with x rays has stripped the spirals of their gas. A few are visible in 6- to 8-inch scopes. But the Coma Cluster really comes into its own with a large scope. In a 16 inch, the field centered on NGC 4874 and NGC 4889 looks like a swarm of bees hovering around two hives with up to two dozen galaxies visible in a 20' circle.

Of the two presiding giants, NGC 4889 is both slightly brighter and larger. In a 13-inch scope, the galaxy appears as a moderately bright oval oriented east-west with several diminutive companions huddled within a few arcminutes. NGC 4874 lies just 6' south of a 7th-magnitude star. The roundish, 1.5' glow is only weakly concentrated, but more impressive is the compact halo of many tiny, dim galaxies. Careful viewing can net at least 100 galaxies spread out over several fields in a 16-inch scope.

In contrast, the Hercules Galaxy Cluster is a remarkably diverse collection of spirals, ellipticals, irregulars, and distorted interacting pairs. This sprawling cluster lacks the high degree of organization and central concentration found in the Coma Cluster but maintains a high percentage of gas-rich spirals. At a distance of roughly 550 million light-years, the Hercules Cluster is a challenging visual target even in 12- to 16-inch scopes, so wait for a night of exceptional transparency and plan your attack carefully.

Our jumping-off point is the 7th-magnitude star SAO 101900. Just 10' east-southeast you'll find the interacting system, NGC 6040. The companion may require a 16-inch scope and is found dangling off the south edge. Nearby is a similar double system, NGC 6041 and NGC 6042.



Martin Germano

Martin Germano

Above: Five bright galaxies compose the group Stephan's Quintet. The biggest galaxy, NGC 7320, is closer to us than the other four.
Left: Most clusters are comprised mostly of elliptical galaxies, but the Hercules Cluster offers an unusually large number of spirals.

Just 8' away from NGC 6041, lies another dim trio with NGC 6045 as its centerpiece. This distorted edge-on spiral has NGC 6043 and NGC 6047 as its companions. The intertwined pair of spirals, NGC 6050 and IC 1179, swirl nearby, followed by a string of three IC galaxies oriented north-south. A keen observer with a 16-inch scope may glimpse up to three dozen members within 30' of the central region.

Now that wasn't so bad, was it? And this was just the edge of the celestial forest. A thicket of springtime galaxies awaits your discovery. All you have to do is walk in. ■

Steve Gottlieb is a math instructor living in northern California and has been a fervent deep-sky observer for more than 20 years. You can e-mail him at sgottlieb@telis.org. Richard Jakiel lives outside of Atlanta, Georgia, and contributes frequently to Astronomy. *His latest article, "Where Stars are Born," appeared in the April 1998 issue.*

ORION
TELESCOPES & BINOCULARS

We're easy to remember!
www.telescope.com

Our 24th Year!

TELESCOPES

The SkyView™ Deluxe EQ Series

Features, Performance, and Value That Eclipse the Competition

Motor Drive Compatible!

SkyView™ Deluxe 6" EQ Newtonian

Meet the new "gold standard" for value in the 6" equatorial reflector class. At its heart is a high-precision 6"-diameter **parabolic** primary mirror – not a lesser-performing spherical mirror as you get with some competitive 6" Newtonians. Rolled steel optical tube. Focal length 750mm (f/5).

$599

SkyView™ Deluxe 4.5" EQ Newtonian

An exquisite combination of form, function, and affordability for the serious beginning astronomer. The rolled steel optical tube houses a precision-polished 4.5" primary mirror of 900mm focal length (f/7.9).

$459

SkyView™ Deluxe 90mm EQ Refractor

Exceptionally crisp views of the Moon, planets, and beyond! Multi-coated 90mm achromatic objective lens of 1000mm focal length (f/11.1). Seamless aluminum optical tube.

$549

Outfit your SkyView Deluxe with an AccuTrack™ DC Motor Drive for automatic star tracking.

$99

ORION

Look What's Included!

- *New heavy-duty EQ mount*
- *Built-in polar-alignment scope*
- *TWO 1.25" Plössl eyepieces*
- *6x30 achromatic finder scope*
- *Moon filter (1.25")*
- *Gold-anodized aluminum tripod*

Compare to competing brands, then compare the prices!

Featuring the SkyView™ Deluxe Equatorial Mount

With Built-in Polar-Alignment Scope!

Each SkyView Deluxe telescope is equipped with this rock-stable precision equatorial mount. It features fully enclosed worm gears and dual, high-visibility setting circles. Built-in polar axis scope makes polar alignment a snap! Dual micro-motion cables, large lever-type R.A. and Dec. lock knobs, azimuth fine-adjustment, and latitude scale.

FREE CD-ROM with purchase of any Orion astronomical telescope!

The perfect guide to the sky for new telescope owners!
Requires PC running Windows 98, 95, or 3.1x operating system.

An $89 Value

Where The Stars Are

ORION

ShortTube™ 4.5" EQ Ultra

More portable than conventional 4.5" Newtonians — tube is less than 17" long! Great backyard scope that's loaded with desirable features such as 6x30 finder scope, two 1.25" Kellner eyepieces, heavy-duty equatorial mount with slow-motion cables, and aluminum tripod. Effective focal length 1000mm (f/8.8). Accepts optional AC motor drive.

$399

ShortTube™ 80mm Rich-Field Refractor

The Perfect Solar Eclipse Scope!

Rich-field 400mm f.l., f/5 scope excels for casual observing and prime-focus astrophotography. 6x30 finder, 1.25" rack-and-pinion focuser, 45° erect-image diagonal, and TWO 1.25" Kellner eyepieces. Mounts on a photo tripod or equatorial mount (sold separately). Makes a terrific guide scope, too!

$249

Solar Filter $59.95

Argonaut™ 150mm EQ Maksutov-Cassegrain

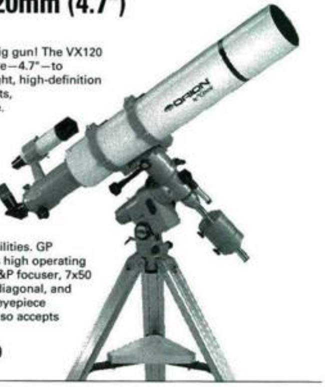
The design heralded for its extraordinary image quality is now very affordable. Now comes with precision SkyView Deluxe equatorial mount and gold-anodized aluminum tripod. Effective focal length is 1800mm (f/12), 150mm (nearly 6") aperture. Gearless Crayford 2" focuser, 7x35 achromatic finder, and padded case for OTA.

$1099

Tube Assembly only $899

Star diagonal and eyepiece sold separately.

VX120 GP 120mm (4.7") Refractor



We're breaking out the big gun! The VX120 has enough clear aperture—4.7"—to deliver exceptionally bright, high-definition views of deep-sky subjects, not just solar system fare. Its 4-element, 2-group objective achromat provides added color correction and field flattening. Relatively fast f-ratio of 6.7 (focal length 800mm) gives it awesome astrophotographic capabilities. GP equatorial mount insures high operating precision and stability. R&P focuser, 7x50 finder scope, prism star diagonal, and 20mm (40x) Lanthanum eyepiece (1.25") come standard. Also accepts optional 2" visual back.

$1999

Premium Deep Space Explorer™ Dobs

Get into astronomy in a BIG way! PDSEs are the ultimate large-aperture scopes for deep-sky devotees—and incredibly affordable. Hand-figured, diffraction-limited Pyrex optics with enhanced 94%-reflective coatings for brighter images. Sonotube optical tube and sturdy, cabinet-quality base. Includes 26mm Sirius Plössl eyepiece (1.25") and choice of selected focusers.

10" PDSE (f/5.6) From $799

12.5" PDSE (f/4.8) From $1029

Shown with optional finder scope.

ORION

Argonaut™ 6" GP-DX Mak-Newtonian

ORION

High-performance optical design on our most advanced equatorial mount, the GP-DX. Relatively short focal length of 900mm (f/6) provides pleasingly wide views. Central obstruction is a mere 28mm, or 18% of full aperture, for refractor-like image quality. Great for deep-sky or planetary viewing. Pyrex mirrors boast high 93% reflectivity. Crayford 2" focuser and 10x50 finder scope standard. Eyepiece not included. Accepts 2" eyepieces. Motor drives optional.

$1999

Tube Assembly only $1149

VX102 GP Refractor

ORION

An instrument of impeccable quality, yet at a modest price. Its 102mm (4") achromatic objective lens of 1000mm focal length (f/9.8) yields exceptional imaging performance. GP equatorial mount is engineered for rigidity and precision movement. Includes illuminated polar scope, 6x30 finder, prism star diagonal, 20mm (50x) Lanthanum eyepiece (1.25"), aluminum tripod, and more. Motor drives or SkySensor "Go To" system optional.

$1199

Tube Assembly only $799

Other VX102 GP Refractors

VX102-ED GP (f/6.5)	$1899
VX102-FL GP (f/9.0)	$2499

MONEY-BACK GUARANTEE
If you are not completely satisfied with your purchase from Orion Telescopes & Binoculars
100% Satisfaction
for any reason, just return it in new condition within 30 days after delivery for a prompt refund.

Visit one of our California Retail Stores!

Some prices in retail stores may vary.

San Francisco • 3609 Buchanan St., at Bay, 1 block from Marina Safeway • (415) 931-9966

San Jose-Cupertino • 10555 S. De Anza Blvd., at McClellan: from Hwy 280, take De Anza exit; from Hwy 85 take De Anza or Stevens Creek exit • (408) 255-8770

Monterey Bay-Watsonville • 89 Hangar Way, off Airport Blvd. near Santa Cruz • (831) 763-7000

24 Hour Toll-Free Orders: (800) 447-1001
Information/Advice: (800) 676-1343

Information Line Hours: M–F 5am–9pm, Sat. 8am–6pm Pacific Time

www.telescope.com

BINOCULARS

Canon

Image Stabilizer Binoculars

"ASTOUNDING! . . . . TRULY A QUANTUM LEAP IN BINOCULAR OBSERVING." — SKY & TELESCOPE (5/98)

Enjoy hand-held, high-power binocular viewing without shaky images! Special microprocessor-controlled prisms provide rock-steady views. You'll see fainter objects and much more detail. *S&T* raved: "The price and proven performance of the Canon binoculars will certainly make them a hot item for amateur astronomers." Fully multi-coated optics, tack-sharp images edge to edge.

10x30 IS	12x36 IS	15x45 IS
Field of view 6.0°.	Field of view 5.6°.	Field of view 4.5°.
$599	$949	$1399

ORION

80mm Binocular Telescope

INTERCHANGEABLE EYEPIECES!

SKY & TELESCOPE HOT PRODUCTS 1998

Looking through TWO premium-quality 80mm (3.1") refractors simultaneously is an unforgettable experience! Uses interchangeable 1.25" telescope eyepieces, allowing wide range of powers! Includes two 25mm eyepieces (36x, 1.1° field). Mount/tripod sold separately. $879

Custom D Altaz Mount/Tripod
Recommended for Orion BT80. $445

ORION

Fork-Mounted 20x125mm Binocular Telescope

The most powerful truly portable binocular you can buy! Whopping 4.9" multi-coated front lenses of 625mm focal length (f/5). High-power images so bright, sharp, and resolved they'll knock your socks off! Rigid altazimuth fork mount features friction control on both axes, and allows pointing to zenith. Adjustable aluminum tripod. 20mm eye relief. Field of view 3.0°. Weighs 24 lbs. $3650

Deluxe Aluminum Case $379

ORION

Little Giant™ II 70mm Binocular

More compact than the original Little Giants, and now three different powers to choose from—up to 20x! Big 70mm objectives reveal a plethora of nebulous clouds and stellar clusterings. Great for twilight and daytime use too. Sharp, fully multi-coated optics with BAK-4 prisms and centered lenses. Large, knurled center focus wheel. Classic black coarse-grain finish provides a sure grip. Tripod L-adapter, case, and deluxe wide neck strap included. Made in Japan.

11x70 Little Giant II	15x70 Little Giant II	20x70 Little Giant II
Field of view 4.5°	Field of view 4.0°	Field of view 3.0°

$269

ORION

UltraView™ 50mm

Best Bino Available For Eyeglass Wearers

Extra-long 22mm eye relief and unique pop-down eyeguards. Fully multi-coated. BAK-4 prisms. Tripod adaptable.

7x50, 10x50 WA $179

ORION

Mini Giant™

Large Apertures in Compact Bodies

Great astro binoculars! Fully multi-coated optics, BAK-4 prisms. Long 18mm eye relief. Tripod adaptable.

8x56	$159
9x63	$189

ORION

Giant 80mm

Enjoy stunning resolution. Fully multi-coated optics with BAK-4 prisms. Objective bridge for added rigidity. Center focus. Tripod L-adapter included.

11x80 Giant
4.5° field, 16mm eye relief.

16x80 Giant
3.5° field, 16mm eye relief.

20x80 Giant
3.5° field, 15mm eye relief. $399

ORION

SuperGiant™ 100mm

Gigantic 100mm (almost 4") lenses for unbelievably detailed views of the heavens! Fully multi-coated optics with BAK-4 prisms. Platform-type mounting plate included.

14x100 SuperGiant
Individual focus. 3.3° field, 14mm eye relief. $1249

25x100 SuperGiant
Center focus. 2.6° field, 10mm eye relief. $1249

EYEPIECES & ACCESSORIES

Sale!

- **Buy one .... regular price**
- **Buy two .... $15 OFF**
- **Buy three .... $30 OFF**
- **Buy four .... $50 OFF**
- **Buy five .... $75 OFF**

Discounts apply to total dollar sum for multiple eyepieces, not per eyepiece. Prices shown are regular prices.

Sirius™ Plössl Eyepieces

You could pay twice the price for other brands of Plössl eyepieces, but why? Sirius Plössls are top-quality, 50° apparent-field (43° 40mm) eyepieces that yield extremely sharp images of impressively high contrast. Ideal for all types of telescopes. Fully-coated optics, rubber eyeguards. Stock up today!

1.25"
6.3mm, 7.5mm, 10mm, 12.5mm, 17mm, 20mm, 26mm $49.95 each
32mm, 40mm $59.95 each

.965"
6.3mm, 7.5mm, 10mm, 12.5mm, 17mm, 20mm, 26mm $49.95 each

Ultrascopic™ Eyepieces

The highest contrast and light transmission obtainable. Superior 5- or 7-element design with *Ultra Multi-Coatings* on every surface. Wide 52° apparent field. Removable winged rubber eyeguard. Threaded for filters. 1.25" barrels.

3.8mm, 5mm, 7.5mm, 10mm, 15mm, 20mm, 25mm, 30mm, 35mm
From $79

Explorer II™ Eyepieces

Attractively priced for even limited budgets. Their 3- and 4-element fully coated glass lens configurations provide a 50° apparent field of view. Threaded for filters.

1.25"
6mm, 10mm, 13mm, 17mm, 25mm
$33.50 each

.965"
6mm, 10mm, 13mm, 17mm, 25mm
$27.95 each

Lanthanum 65° Superwides

Combining long 20mm eye relief, an expansive 65° apparent field, and a rare-earth lanthanum lens element for superior image correction, these oculars are an astronomer's dream come true. Eight lens elements, multi-coated. Fit 1.25" or 2" focusers.

8mm	$205
13mm	$214
17mm	$222
22mm	$222

Collimating Eyepiece

Combination Cheshire eyepiece and sight tube. Essential for optimizing performance of fast Newtonians. Far less expensive than laser collimators, yet just as effective. Anodized aluminum. $34.95

SkyView™ Deluxe Equatorial Mount

Extra-sturdy equatorial head. Enclosed worm gears, slow-motion cables, plus a built-in polar-alignment scope! Unique gold-anodized aluminum tripod. $239

Sale! 25% Off

Shorty™ 2x Barlow Lens

Doubles the power of any eyepiece.

.965"	~~$44.50~~	$32.95
1.25"	~~$44.50~~	$32.95

EZ Finder™

Illuminated "red dot" in nonmagnified 9° field of view shows right where telescope is pointed. Adjustable brightness. Attaches to any telescope. $39.95

SkyGlow™ Broadband LP Filters

Sale! 25% OFF

Improves contrast of all objects in moderately light-polluted skies.

.965"	~~$44.95~~	$33.70
1.25"	~~$59.95~~	$44.95
2"	~~$109~~	$81.75
SCT Rear Cell	~~$89.95~~	$67.45

UltraBlock™ LP Filters

Maximum contrast enhancement for emission nebulas.

.965"	~~$79.95~~	$59.95
1.25"	~~$99.95~~	$74.95
2"	~~$149~~	$111.75
SCT Rear Cell	~~$149~~	$111.75

Sale! 30% OFF From Year Ago

Color Filter Sets (1.25")

These filters bring out subtle markings and details of planets, lunar surface, and comets.

Basic Set of 4
Expansion Set of 4
Advanced Set of 4
~~$49.95~~ $34.95 per set

Sale! 20% to 25% OFF

Moon Filters

Cut lunar glare to reveal much more surface detail.

Standard .965"	~~$15.95~~	$12.75
Standard 1.25"	~~$15.95~~	$12.75
Variable Polarizing .965"	~~$29.95~~	$22.45
Variable Polarizing 1.25"	~~$39.95~~	$29.95

Sale! 20% OFF

Orion 6x30 Finder Scope

All glass achromatic optics in gloss-white aluminum tube. Wide 5.2° field of view with crosshairs. Dual ring bracket with six-point alignment.
~~$39.95~~ $31.95

Accessory Cases

Small Case	$19.95
Medium Case	$27.95
Large Case	$47.50

Soft Cases for Telescopes
For many different models.
From $38.95

Clearance Sale! $10 to $20 OFF! (white models only) While supplies last

Orion 8x50 and 9x60 Finders

Precision, large-aperture finders for medium and large telescopes. Dual-ring aluminum brackets sold separately.

8x50 illum. (white)	~~$119~~	$99
8x50 std. (white)	~~$74.95~~	$64.95
9x60 illum. (white)	~~$159~~	$139
9x60 std. (white)	~~$109~~	$94
Dual-ring Bracket for 8x50		$34.95
Dual-Ring Bracket for 9x60		$39.95

More than 1000 products in our print & online catalogs!

ORION
TELESCOPES & BINOCULARS
Sale!
Sale!
Sale!

ORION
TELESCOPES & BINOCULARS
P.O. BOX 1815-S, SANTA CRUZ, CA 95061

Full Online Catalog
www.telescope.com

IT'S EASY TO ORDER!

- Call toll-free and charge to your Discover/Novus, MasterCard, or VISA Card, or send your personal check to order by mail. Mail Orders to: P. O. Box 1815-A, Santa Cruz, CA 95061-1815. Fax Orders to: (831) 763-7017.
- California residents add 7.25% sales tax 8.25% in Santa Clara County; 8% in Santa Cruz County; 8.5% in San Francisco).
- Shipping and handling charges additional. Call for rates. Delivery in U.S. and Canada only. Expedited delivery available.
- Prices are subject to change or correction without notice.
- Sale prices good through April 15, 1999, or while supplies last.

FREE 100-PAGE CATALOG CALL (800) 447-1001

MasterCard DISCOVER NOVUS VISA

When ordering, mention key code SCA

Exploring Crater Rays

One of the few features that stand out prominently at full moon, crater rays mark fresh deposits of material kicked up by mammoth impacts.

by Jim Bell

Only in the last few decades have astronomers realized that impact cratering is the most powerful and extensive geologic process in the solar system. Earth's surface is so young (relatively speaking) and dynamic that most of the evidence of the intense bombardment suffered by our planet early in its history has been wiped clean by the action of wind and water and moving continental plates. But the proof is still spectacularly preserved on the lunar surface in the form of impact basins, craters, and the bright streaks of lunar dust known as rays.

Even a casual glance at the moon with the naked eye reveals the evidence firsthand: The large circular basins filled with dark lava that form the famous "man in the moon" pattern originated when massive, rocky objects slammed into the lunar surface. Exploring the moon with a small telescope, even at low magnification or from a well-lit city, shows that craters saturate the lunar surface.

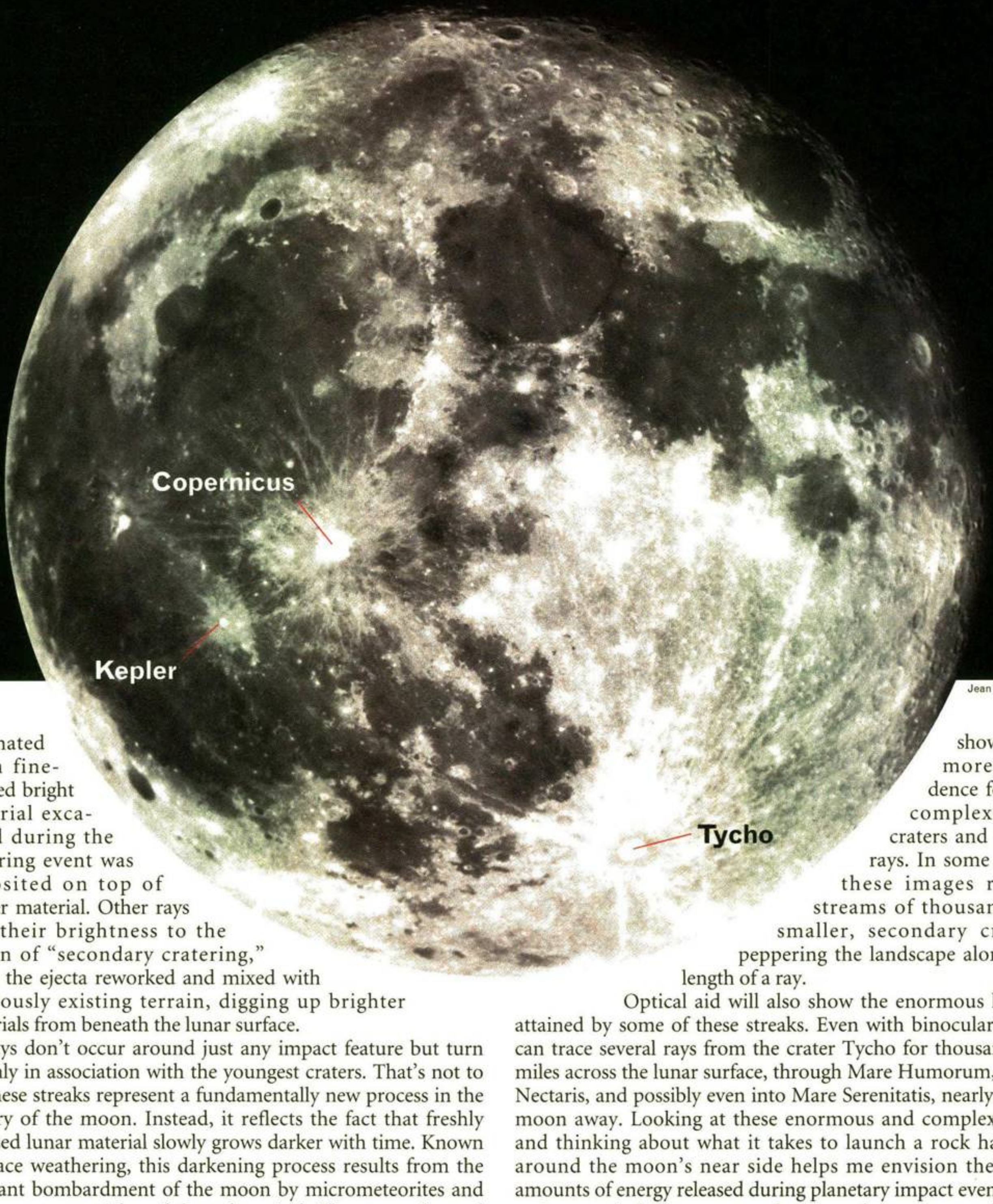
Surely if the surface of our celestial companion bears the scars of impacts occurring over the eons, then Earth also must have experienced a similar bombardment. Fortunately for our species, most of this action happened in the first billion or so years of solar system history as the debris from the formation of the planets cleared. Events such as the 1908 Tunguska explosion over Siberia and the 1994 Comet Shoemaker-Levy 9 impact with Jupiter — as well as the recent Hollywood blockbusters *Deep Impact* and *Armageddon* — remind us that impacts are still powerful, albeit rare, forces.

Special effects aside, what really happens when an asteroid or comet slams into a planet's surface? Pioneering lunar scientist Ralph Baldwin once wrote that an impact crater is what happens when an irresistible force meets an immovable object. The result: an explosive release of energy — and a big hole in the ground. The moon provides a natural laboratory to study this process, and many astronomers try to reproduce the shapes and styles of lunar craters by examining natural and man-made explosion craters on Earth and by performing high-speed impact experiments in laboratories.

These studies show that most craters form in a sequence of events that lasts just a few minutes. High-pressure shock waves dominate the action, vaporizing the impacting object and much of the area around the impact site. They also spray or jet millions of tons of rocks and finely crushed rock powder (called ejecta) away from the crater on what can be long trajectories. Anyone who has ever stomped in a puddle or thrown a rock into the mud is, besides wet and dirty, intimately familiar with jetting. Laboratory studies and computer simulations show that some of the ejecta can be sprayed from a crater at speeds far greater than that of the impacting object and, in some cases, even reach escape velocity. Most astronomers suspect this is how rocks such as the famous martian meteorite ALH84001 and a couple dozen other known martian and lunar meteorites began their journey to Earth.

You can see the results of such jetting by turning binoculars or a small telescope on the moon. Look for bright, linear features radiating from small to medium-sized craters — the most spectacular emanate from Copernicus and Kepler on the west side of the moon and Tycho in the south. Aptly named rays, these features look like beams of sunlight dappled on the lunar surface. The best time to hunt for rays occurs around full moon, when shadows are absent or small and the contrast between bright and dark regions is highest.

The rays we observe formed from a complex combination of two processes. Some stand out prominently because they



Jean Dragesco

originated when fine-grained bright material excavated during the cratering event was deposited on top of darker material. Other rays owe their brightness to the action of "secondary cratering," when the ejecta reworked and mixed with previously existing terrain, digging up brighter materials from beneath the lunar surface.

Rays don't occur around just any impact feature but turn up only in association with the youngest craters. That's not to say these streaks represent a fundamentally new process in the history of the moon. Instead, it reflects the fact that freshly exposed lunar material slowly grows darker with time. Known as space weathering, this darkening process results from the constant bombardment of the moon by micrometeorites and high-energy particles of the solar wind. Thus, rays formed early in the moon's history have faded from view, just as the glorious ray systems we see today will someday meld into the background. In turn, these likely will be replaced by fresh rays formed in impact events yet to come.

As you explore lunar crater rays with a telescope, notice that they are not all perfectly straight nor do they radiate perfectly from their central crater. They often are fraught with knots and kinks and bends, attesting to the complex interactions among boulders and fine debris that must have occurred as the material was being launched out of the crater. High-resolution images from the Apollo and Clementine spacecraft show even more evidence for the complexity of craters and crater rays. In some cases, these images reveal streams of thousands of smaller, secondary craters peppering the landscape along the length of a ray.

Optical aid will also show the enormous length attained by some of these streaks. Even with binoculars, you can trace several rays from the crater Tycho for thousands of miles across the lunar surface, through Mare Humorum, Mare Nectaris, and possibly even into Mare Serenitatis, nearly half a moon away. Looking at these enormous and complex scars and thinking about what it takes to launch a rock halfway around the moon's near side helps me envision the huge amounts of energy released during planetary impact events.

In my mind, crater rays rank among the most rewarding of all lunar features. Although fragile and ephemeral, they are easy to observe. Next full moon, grab your binoculars or a small telescope and go hunting for rays. Then imagine what it would have been like to witness the creation of these beautiful reminders of the powerful forces that have shaped, and continue to shape, our solar system. ◼

Jim Bell is a planetary astronomer at Cornell University in New York who enjoys observing the moon and planets through his 8-inch Newtonian telescope on the rare clear nights in Ithaca.

• 2 GREAT LOCATIONS TO SERVE YOU • CALL OR WRITE FOR OUR FREE CATALOG

POCONO POCONO

CALL OR WRITE FOR OUR FREE 40 PAGE CATALOG
FREE 35MM CAMERA WITH EVERY ORDER
$50.00 OR MORE!

Visit Our Two Showrooms in Moscow, PA and Las Vegas, NV!

SUPER SPECIAL!!

Apogee 6" Newtonian Reflector

f5/762MM f.l.

STANDARD EQUIPMENT:
German Equ. Mount, Aluminum Tripod, Altitude & Azimuth Adjusters for Polar Aligning, Accy. Tray, Slo-Motion Controls in both axis, Setting Circles, 10MM & 25MM 1.25" Plossl Eyepieces, 1.25" Rack & Pinion Focuser, 6x30 Finder & Bracket, Aluminum Tube & 6x20 Polar Bore Scope.

$499.00

DC powered Motor Drive............$95.00
Also available in 4.5" version $399.00
Both scopes use parabolic mirrors

SKY/mount by VIRGO

$174.95
(Tripod optional)

- All Aluminum, elegantly machined construction -steel weights
- Baked on, black ceramic finish- scratch resistant
- Popular "flexible parallelogram" holds aim at any height
- Easy set up on any heavy-duty tripod
- Secure, stable and easy to use for almost any size binoculars
- Tight-grip knobs reduce position slippage

Heavy Duty Bino Mounting Bracket...$25.00
Sure/Grip Holder for Large Binos.......$40.00

ETX ACCESSORIES BY APOGEE

Right Angle Finder Conversion..........$59.00 ETX to 1.25"..........$29.95
ETX Mini Tele-Extender..........$29.95 LAR Adapter (for SCT Accy's)....$29.95
Wide Field Adapter (Requires ETX 1 1/4" Adapter)....................$89.95
NEW ETX Focal Reducer, speed up your photos and get wider angle shots.
Camera and T-Ring thread directly to Focal Reducer...............$59.95

PORTA PACS -12 Volt Batteries

5 AMP HR. ....$75.00 12 AMP HR.......................$86.95
17 AMP HR. ....$119.00 All come with rechargers

PENTAX XL SERIES EYEPIECES

Available in the following FL: 5.2, 7, 10.5, 14, 21, 28 and 40MM.

Desert Storm Covers

Protect your investment-
Covers available for all size scopes.
Manufactured with a thick mylar "heat resistant" material

4"- 6" Dobs & SCTs...............$21.95
7" -8" Dobs & SCTs...............$26.95
10" -13" Dobs & SCTs...........$32.95
14" SCTs................................$38.95
16" -18" Dobs.........................$44.95
20" -25" Dobs.........................$54.95
Dealer Inquiries Invited

NEW FROM POCONO MOUNTAIN OPTICS-
EYEPIECE & ACCESSORIES CASES
Standard-19 1/4"x13"x7"................................$49.95
Deluxe Waterproof-17"x12"x7"........................$69.00
Large Deluxe Waterproof-19"x14"x18"..........$89.00

Tele Vue "WHEN YOU WANT THE FINEST"

We stock the entire Tele Vue line for immediate shipment. All items also on display and available for purchase and pick up at both of our showrooms.

Imagine a Walk in Space!

NAGLERS 82° Apparent Field of View

Patented Tele Vue Naglers offer the widest, sharpest views available.
Choose from 4.8 MM $175., 7 MM $220., 9 MM $240.,16 MM $310.and the amazing 20MM $395.

PANOPTICS 68° Apparent Field of View

Attack you sharpness problems with Tele Vue's newest eyepiece-the Panoptics. The 2" 35mm and 27mm are considered to be the sharpest in their focal length class. The 1 1/4" 22mm, 19mm and 15mm offer outstanding performance, lighter weight, smaller size and lower cost when compared with similar focal length Naglers.

Tele Vue's Best Eyepiece Value!

PLOSSLS 50° Apparent Field of View

Patented Tele Vue Plossl eyepieces started the trend toward higher-quality, high-performance eyepiece designs. And today, despite the many imitators available, they still deliver the sharpest views in their class. Available in sizes:1 1/4" 8, 11, 15, 20, 25, 32, 40fl. Don't forget the 2" 55mm, which yields the widest true FOV available.

MONTHLY SPECIAL
PRONTO w/2" DIAGONAL
Panoramic Mount and Quick Point Finder
POCONO MOUNTAIN OPTICS EXCLUSIVE

PRONTO

70MM AP.6.8, 480MM F.L. Available in
1 1/4" Image Erect...................$925.00
1 1/4" Star Diagonal $945.00
2" Star Diagonal model.........$1085.00
"The little Scope - that could"

TV-85

85MM Aperture, F-7
600MM fl
As reviewed in Sky & Telescope Magazine. $1995.

2.5x Powermate........$168.00
5x Powermate...........$168.00
New 4x Powermate now avail.
New Bino Vue $1030.00
8MM to 20MM ZOOM ...$210.00
New Everbrite 2" Star Diag. ..$255.00

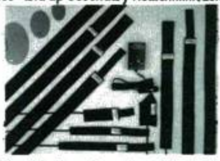
--New for 1999--
Tele Vue Announces
RADIAN™ EYEPIECES have arrived!
10MM AND 14MM NOW IN STOCK

20MM eye relief, 60° apparent field of view and Tele Vue's unique "Instadjust™" click stop barrel for variable eye relief. All parafocal currently available.3, 4, 5, 6, 8,10,12 & 14MM focal length available. **$228.00** each!

The Kendrick Dew Remover System for all size scopes,finders and mirrors

Dew Controller
(Works up to 4 Heaters)........................$64.00
120 Volt Conversion Kit........................$59.00
.965"/1.25" Eyepiece Dew Heater......$30.00
1.25"/2" Eyepiece Dew Heater...........$33.00
2" Dew Heater.......................................$34.00
3" Dew Heater.......................................$38.00
4" Dew Heater.......................................$41.00
5" Dew Heater.......................................$44.00
5.5"/6.5" Dew Heater.............................$45.00
7"/8" Dew Heater...................................$49.00
9"/10" Dew Heater.................................$59.00
11" Dew Heater.....................................$63.00
12" Dew Heater.....................................$68.00
14"/16" Dew Heater...............................$77.00
Telrad Heater.......................................$19.00

1.83"/2.14" Secondary Heater...........$22.00
2.60"/3.50" Secondary Heater...........$24.00
4.00" and up Secondary Heater........$25.00



Flexible Dew Caps from Kendrick

ETX 90mm - $25	7/8" - $49	11" - $68
5" - $31	9.25" - $52	12" - $83
6" - $41	10" - $59	14" - $99

CELESTRON *We carry the full line of Celestron Telescopes and Accessories*

G-5

World Famous C-5 Optics on Equatorial Mount, 1250 MM FL. 6X30 Finder. In stock with Motor Drive.

CELESTAR 8

2032 MM FL., Heavy Duty Adj. Tripod Dec Motor and Hand Control. 4 Tracking Rates and PEC Fastar Compatable. In Stock for Immediate Shipment.

ULTIMA 2000

Ultra Quiet Motors and Go To Impressive Pointing Accuracy. Runs off 8 AA Batteries. Enhanced Encoder Resolution. Fastar Compatable at F-2 for CCD use. 9X50 Finder. In Stock and Impressively Priced.

STARHOPPER DOBSONIANS

Available in 4.5", 6", 8", 11", 14" and 17.5". Diffraction Limited Optics

CM 11/CM 1400

2800 FL. for 11". 3910 for 14". 9X50 Finder, Hand Control, Manual Slo Mo Controls. Dual Axis PEC Electronics with 4 Tracking Rates. Ultra Stable Eq. Mount. Built in Polar Finder and Backlash Compensated.

C-5+

For the astronomer on the go or for anyone who wishes for an ultra portable SCT, the C-5 Plus can't be beat! 1250MM FL. Unique Single-Arm Fork Mt. with Carrying Handle. Table Top Wedge which can be tripod mounted. DC RA Drive runs off 9 volt battery. In stock.

PIXEL 237 IN STOCK-
Uses TI 237 Chip, High Quantum Efficiency to be used with Fastar System.

POCONO MOUNTAIN OPTICS

104 NP 502 PLAZA, MOSCOW,PA 18444
Fax: 570-842-8364 E-mail us at pocmtnop@ptdprolog.net

ORDER HOURS: 9-9 Mon.-Fri.,
9-5 Sat., 12-5 Sun.
SHOWROOM HOURS: 10-5 Mon.-Sat.,
12-5 Sun.

MOUNTAIN OPTICS
WEST OPTICS

ORDERS: 800-569-4323
INFO: 570-842-1500
ORDERS: 800-635-3607
INFO: 702-252-7200

YOUR MEADE AUTHORIZED ADVANCED PRODUCTS MAIL ORDER DEALER

Meade Dobsonians: Available in: 6"F/8, 8"F/6,10" F/4.5, 12.5" F/4.8, 16" F/4.5, optional deluxe accessory package $49.95

Meade Model 395-90MM, F-11 Refractor on Equatorial Mount. 1.25" Rack and Pinion Focuser, Manual Slo-Motion controls, 6x30 Finder Scope. $599. We have a limited supply of cosmetic blems that in no way effect optical performance $429.

Meade LX-200 SCT's,The World Famous "GoTo" Telescope Available in 8" F/10 or F/6.3, 10" F/10 or F/6.3, 12" F/10, 16" F/10.

Meade Equatorial Starfinders, Available in: 6"F/8, 8"F/6, 10"F/4.5, 16"F-4.5. Complete with DC, RA Motor Drive, 2"Focuser and Finder.

New Meade ETX-90/EC-with pushbutton electronic control comes standard with dual-axis drive system W/4 dual axis speeds. Add the Meade Autostar hand control to your scope and get fully automatic go to capability to over 12,000 objects. Available Now. $595.

Meade Model 4500-Ideal for the Beginning Amateur: 4 1/2" Reflector on Equatorial Mount, Manual Slo-Motion Controls, 6x30 Finder Scope $399.00
531 DC RA Motor Drive Available
We have a limited supply of cosmetic blems that in no way effect optical performance $329.

ACCESSORIES FOR ETX AND NEW ETX-90 /EC	
#126 Barlow	$47.95
#64 T-Adapter	$30.
#932 Image Erect Diagonal	$42.
New Hard Case	$99.95
New 8X25 right Angle Finder	$49.95
ACCESSORIES FOR NEW ETX-90/EC	
Auto Star Hand Control for Go To Capability	$149.
ETX Motofocus	CALL
Equatorial Table Top Tripod (w/Hi Lat Leg)	$29.95
New Standard Full Length Alt-Az. Tripod	CALL
ACCESSORIES FOR ORIGINAL ETX	
Soft Case $39. Deluxe Tripod	$199.
Meade 8" LX-10	**$995.**
Super Wedge	$395.
New Field Derotator for 8", 10",and 12" SCT's, and 7" Maksutov	$395.
Magellan I	
#2010 for all Meade Dobsonians	$295.
#2011 for DC Starfinders-6"-8"-10"	$295.
#2014 for LX-10	$375.
Magellan II	
#2018 for DC Equatorial Starfinders-6"8"10"	$495.
#2024 for LX-50	$495.
3000 Series Plossls 5,6.7,9.5,16,25MM	$49.95
3000 Series Plossls 40MM	$79.95

World Renown Series 4000™ Eyepieces

Complete line in stock for immediate delivery!

- **S.B.I.G. CCD Cameras**
- **Stocking Takahasi Dealer**
- **Apogee Cameras, AP-7 Call for Price**
- Optec Focal Reducers
- Homeyer Flip Mirrors
- Parallax Mounts & Accessories
- Rainbow Optics Star Spectroscope
- We stock Schuler CCB Filters
- Brandon/Questar eyepieces

INTRODUCING!

Apogee's New 4" F/6.4 "Widestar" Richfield Refractor. Complete with 2" Focuser, 2-1.25" Adapter, 1.25" Star Diagonal and 25MM Plossl. Introductory Price: $795.00

BINOCULARS!

Fujinon FMT SERIES

Ideal for Astronomy

Contact us for the best pricing on the best binoculars for Astronomy - 6x30 FMTR-SX, 7x50 FMT-SX, 7x50 FMTRSX, 7x50 FMTRCSX The unbelievable 10x70 FMT-SX and the 16x70 FMT-SX.

7x50 and 10x70 have eye relief of 23MM. 16x70 has eye relief of 12.4MM.

Tripod Adapter Bracket (Available for immediate shipment)	$18.00
Heavy Duty Virgo Bino Mounting Bracket	**$25.00**

We also carry and stock Zeiss, Swarovski, Swift, Nikon, Pentax, B&L, Steiner, Minolta and Kowa spotting scopes.

JIM'S MOBILE

We stock the entire JMI line-SPECIALS

MotoFocus for LX5/6/200	**$95.00**
Moto Decs--for all Meade SCTs	**$85.00**
C-8 Moto Dec	**$85.00**
SCT Owners; avoid image shift-- NGF-S Focuser w/MotoFocus	**$249.00**

Wheeley Bars for all Scopes:

For Meade/Celestron SCT's w/Levelers	**$145.00**
Also Available for Meade 12"/Celestron 11"	**CALL**

NEW ACCESSORIES FOR ETX:

Wedge w/Levelers	$115.00
Tripod	$115.00
MotoFocus/MotoDec Combo w/hand control	$165.00
New Piggyback Bracket for ETX	$48.00
New Hard Case for ETX	$99.00

RIGEL SYSTEMS

Starlite Dual LED Flashlight	$22.00
NEW Skylite: Dual Color LED Flashlight	$29.95
Quick Finder-New Version	$35.00

BEATTIE INTENSCREEN-PLUS
Ultra Bright focus screens for:

Olympus OM 1, 2, 3, 4,	**$62.00**
Nikon F, F2, F3	**$93.95**
Nikon FE, FE2, FM2, FA	**$62.00**

LOSMANDY GM8 Mount
Complete System Package

Dual Axis, PEC DRIVE, North-South operation.Three photo guide rates. Auto guider ready. Four tracking rates. Adapter Plate. (Specify Telescope) 7 lb. counterweight. Weight capacity–30 lbs

The GM-8 is perfectly suited for the following telescopes–Astro Physics 4" Traveler, Astro Physics 5" F-8, Celestron C-5, C-8, C-9, 25SCT,Celestron 102 Refractor, Caravolo HD-145, Meade 8" and 10" SCT, Meade 4" and 5" APO, Tele Vue Pronto and Genesis and new Meade 7" Maksutov.

New Price:

$1449.00 Includes Shipping
FREE Polar Finder w/Mount

LOSMANDY G11 MOUNT

$1895.00 Includes Shipping
FREE Polar Finder w/Mount

POCONO EXCLUSIVE SPECIAL
Losmandy Digital Setting Circles

- 9000 + objects includes Messier, NGC., planets and add up to 59 of your favorites. Epoch 2000 coordinates.
- Liquid crystal display, backlit, heated.
- Rs-232 Serial Port

Complete module with encoders and mounting hardware	$595.00

Tectron Collimators Improve Newtonian Images with the following:

Sight Tube	$29.
Cheshire Eyepiece	$38.
Auto-collimator	$31.
Above 3 with Booklet	$95.
New "Revised" Booklet on Collimation	$ 8.

TELRAD w/Base
$39.00
Batteries included!

Hinged Deluxe Dew Caps	$10.00
Extra Bases	$ 7.95
Extra Reticles	$ 2.95
Pulsar Unit	$19.95

AstroBeam
LASER COLLIMATOR

SPECIAL PRICE ***The #1 Laser***
$155 ***Preferred by Amateur Astronomers***

Quick, easy, and accurate collimation for Newtonians ∗ Exclusive 2 lens 5mW red diode laser module ∗ Tested and aligned at 100 ft On/Off ∗ 1.25" / 2" body accurate within .0005" ∗Gold anodized alum 2 AA bateries ∗ Powerful diagnostic tool ∗ One Year Guarantee

THE SERIES II
GERMAN EQUATORIAL MOUNT
Ideal for Small Telescopes, Spotting Scopes and Telephoto Lenses

Featurung:
- Quick Release Dovetail Instrument Platform with Balance Adjustment
- Dual Adjustable Counterweights
- Self-Contained DC Right AScension Drive
- Adjustable Drive Clutch
- Declination Axis Lock Attaches to 1/4 or 3/8 Tripod Mount

Now Available with Quartz Drive	$435.
Now Available: Piggy back mount for attachment to Counterweight shaft – allows attachment of additional camera	$24.00

New Polymer Plus Solar Filters by THOUSAND OAKS OPTICAL
Available in all sizes, Full Aperture, Off Axis and also available for camera lenses. Unsurpassed sharpness. Contact us for details today!

NEW NEBULA FILTERS
Type LP-1 Broad Band, Type LP-3 Oxygen, Type LP-2 Narrow Band, Type LP-4 Hydrogen. Available for 1.25"& 2" eyepieces. From $89.00

COMPUTER SOFTWARE
"THE SKY" by Software Bisque

Starry Night Deluxe	**$89.95**
Star Chart 3	**$39.95**

The Sky, Level 4 version 5 Now Available.

OBSERVE IN COMFORT
with

STAR-BOUND

VIEWING CHAIR

- **Portable, Adjustable from 9" to 32"**
- **Padded Seat**
- **Porcelain Black Powder Coated**

NOW ALSO AVAILABLE IN WHITE

Dealer Inquiries Invited **$159.00**

FINDER SCOPES

7x50 Straight Through Finder	$59.95
7x50 Right Angle Finder	$109.95

Pocono gladly accepts:
with no surcharge

Visit our home page at:
http://www. astronomy-mall.com

WORLDWIDE SHIPPING
$6.00 minimum shipping/UPS (in U.S.)

Purchase orders from qualified institutions gladly accepted.

We purchase and take in trade used telescopes.

POCONO
WEST
OPTICS

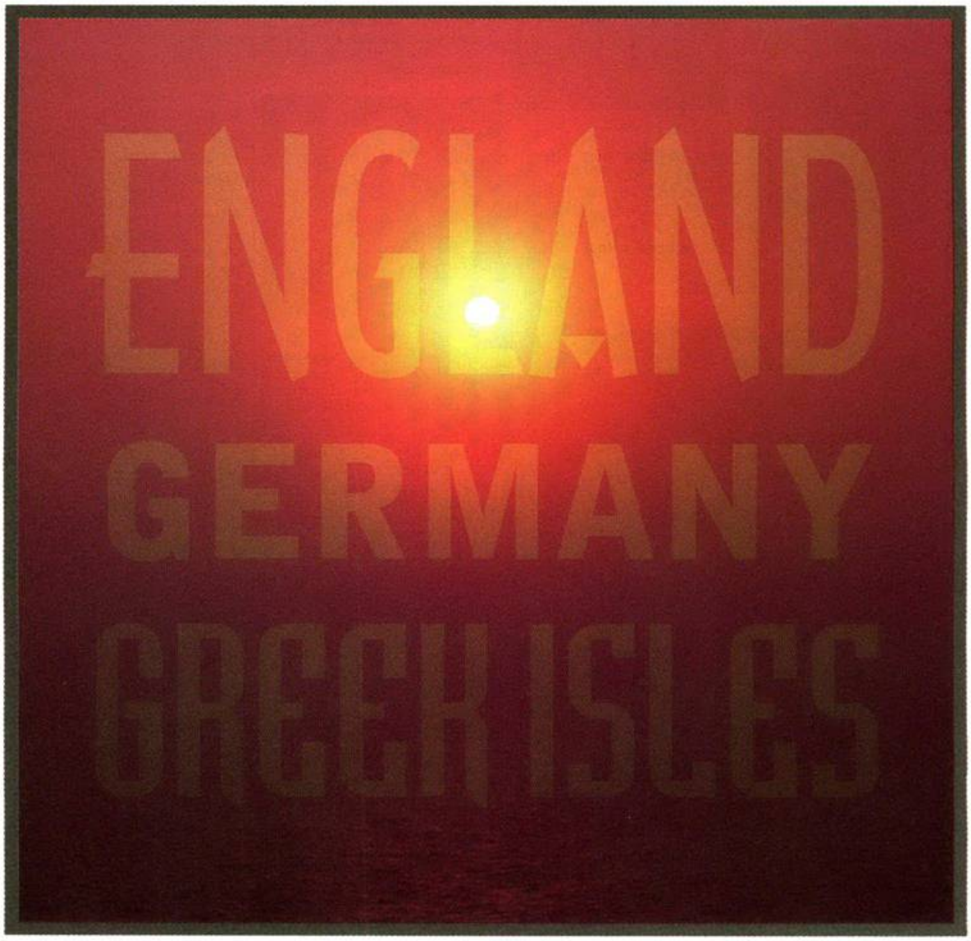
POCONO WEST OPTICS
2580 S. Decatur #3, Las Vegas, NV 89102
Fax: 702-252-7130 E-mail us at poconowest@bigplanet.com

ORDER HOURS: 9-9 Mon.-Fri., 9-6 Sat., 10-5 Sun.
SHOWROOM HOURS: 10-7 Mon.-Fri., 10-5 Sat., 11-4 Sun.

Mention Ad A-7

Astronomy Magazine presents

1999 solar eclipse tours



Come join ***Astronomy*** Magazine on one of its four amazing solar eclipse tours being held August 6-15, 1999. Along with catching one of the most spectacular views of the last solar eclipse of the 20th century, you will experience the magnificent sights and sounds of such wonderful places as England, Germany, and the Greek Isles in the process. Choose your favorite destination today.

ENGLAND—Visit Stonehenge and Avebury, and be treated to a special evening reception at the Royal Greenwich Observatory. You'll also enjoy a special lecture from astronomy professors at Cambridge, and visits to places such as King Arthur's Camelot, the Battlefield at Sedgemoor, and the home of William Herschel, the man who discovered the planet Uranus, and much more. Both a five-star and three/four-star tour are available.

GERMANY—You'll begin your tour in Munich, the city of festivals, and will help celebrate the special German Festival of the Eclipse. Visit the beautiful Alps, as well as many castles, planetariums, and observatories as you travel along the path of the eclipse.

GREEK ISLES CRUISE—Cruise the ancient coastlines of Greece and Turkey on a 300-passenger ship and view the eclipse from the Black Sea north of Istanbul.

SPACE IS LIMITED SO DON'T DELAY!

For more information call Specialty Tours today at 1.800.677.9412

2785-9810

Anyone can sell you a telescope.

Authorized Meade Dealer

We'll sell you the *right* telescope.

Meade ETX-90/EC
$595

Hardly a day goes by that we don't get a note or E-mail message like the one reprinted below, or a call that goes something like this: "Your ads are right. So and so on the East Coast advertises low prices – but they don't have what I want in stock, they couldn't answer *any* of my questions, and they wanted my credit card number before they'd even *talk* to me. They said if I wanted to ask questions, I should call the manufacturer . . . and then they hung up on me!" One of our customers added, "If I wanted that kind of abuse, I would have called my ex-wife."

If you want the right telescope, you need more than just a camera store clerk with a price list, a surly attitude, and a wild guess.

What you *really* need are people who will take the time to listen to what *you* need, people with years of experience using and selling telescopes, people who can help you get the most telescope for your dollar. That's exactly the kind of people you'll find at ***astronomics***.

Unlike camera stores and shopping mall gift shops, telescopes are our specialty at ***astronomics***, not a sideline. We're a family-owned full-line telescope dealer – not just a few scopes stuck off in the corner of some no-help department store, toy store, or gift shop as an afterthought. We don't work on commission, so we won't try to sell you more than you need just to pad our paychecks.

We've been helping people choose the right telescope since 1979. We have the experience to help *you* pick the scope that fits your needs . . . *and your budget* . . . from the many Meade, Celestron, TeleVue, Takahashi, and Questar telescopes we stock at discount prices from $109 to $27,995. (We had 534 scopes *in stock* as we wrote this on 2/2.)

astronomics. No hard sell. No guesswork. Just honest advice, the *right* telescope . . . and a good price. Call us at (405) 364-0858 and find out for yourself.

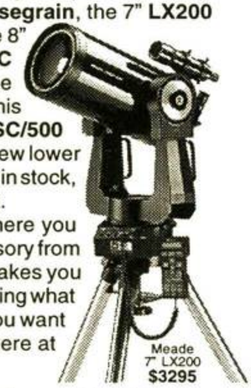
We order Meade telescopes and accessories by the ton . . . literally!

Meade
203SC
$895

The day before this copy was written, we received 305 cartons from Meade – *3¼ tons* of scopes and accessories in one shipment. We don't know of many other dealers – if any – who actually stock Meade products in those quantities . . . no matter what they claim. But we do. Meade scopes, binoculars, eyepieces, filters, Magellan computers, Barlows, off-axis guiders, illuminated reticle eyepieces, counterweights, T-adapters, tele-extenders – we have them all in stock.

It doesn't matter whether the right telescope for you is a best-selling fully computerized 8" or 10" **LX200 Schmidt-Cassegrain**, the 7" **LX200 Maksutov-Cassegrain** to the right; any of the 8" or 10" **LX50** SCTs; the new 3.5" **ETX-90/EC computerized go-to Maksutov** shown at the top of this page (we had 45 of them in stock as this was written); or the 8" German mount **203SC/500** Schmidt-Cassegrain, shown above left at its new lower price. If Meade is shipping it for a dealer to keep in stock, the chances are good that we *have* it in stock.

Meade prices are about the same anywhere you call. So why order a Meade telescope or accessory from a dealer who charges your credit card, then makes you wait and wait until he finally gets around to ordering what you want? Not when you can get the Meade you want . . . right now . . . at the right price . . . right here at ***astronomics.***



Meade
7" LX200
$3295

> My Meade ETX telescope has been even more fun than I had expected! I have already viewed the Moon, Saturn, Venus and a number of star clusters and diffuse nebula. I look forward to many enjoyable hours behind the eyepiece.
> Thank you for all your expert advice throughout the decision making process. You were right on the money with your assistance. I am certain I will be doing business again, with Astronomics, in the future.
> **Customer Quote of the Month #85**

We order Celestron by the ton, too!

The day this copy was written, we received 3968 pounds of Celestron scopes and accessories in one shipment, giving us a total of 287 Celestron scopes in stock. We don't know of many other dealers – if any – who actually stock Celestron in those quantities. But we do.

Because we buy in large quantities, we can take advantage of special buys – like the three scopes immediately below.

The lowest prices in the known universe on 3 Celestrons!

We truly believe that you won't find a lower price *anywhere* on these three Celestron German equatorial mount Schmidt-Cassegrains – the new 11" CM1100, the 8" G8 with dual-axis drive corrector, and the new 14" CM1400.

Our prices are so low that we had to promise Celestron we wouldn't publish them anywhere. You'll have to call us toll-free at (800) 422-7876 to find out just how much money we'll save you on these great scopes.

Celestron
11"
CM1100
$???
Celestron
8" G8
$???
Celestron
14"
CM1400
$???

CELESTRON

Our free catalog helps you pick the right Meade, Celestron, Questar, Takahashi, or TeleVue scope.

For detailed information on individual products, visit our Web site. Or you can call us at (405) 364-0858 or E-Mail us for your *free* copy of our catalog 99AST. It covers all of the telescopes and accessories we stock – from Apogee, Celestron, DayStar, JMI, Lumicon, Meade, Optec, Pentax, Questar, Rigel Systems, SBIG, Software Bisque, Takahashi, TeleVue, and more. We'll include our 8-page guide on how to pick the right scope and your discount prices on the 1000+ products we carry. (Sorry, U. S. sales only.) The catalog is yours for only the cost of a one minute telephone call. The information we send will make it the most useful minute you'll ever invest in astronomy.

astronomics

Our 20th year of friendly service, good advice, and money-saving prices.

2401 Tee Circle, Suites 105/106, Norman, OK 73069

Toll-Free Order Line: **(800) 422-7876** Catalogs/Questions/Advice: **(405) 364-0858**

24-Hour FAX: (405) 447-3337 E-mail: questions@astronomics.com

Our award-winning Internet address: www.astronomics.com

Telephone hours: 10 to 7 CST, Mon. thru Fri., Saturday 12 to 5. Mastercard, Visa, Discover, American Express. U. S. sales *only*.

No credit card surcharge. $5.95 minimum freight. All returns less freight. Restocking fees apply to returns for credit and to merchandise returned used or damaged.

Home Spiral

Grab a thick blanket to lie back on and your favorite pair of binoculars. It's time to take your child on a tour of the Milky Way.

Kids' Corner

Look up on any clear, dark summer night and the faint band of the Milky Way will catch your eye. It stretches from Scorpius in the south, through Cygnus, down to Cassiopeia in the northeast. This region of bright and dark nebulae, star clouds, and clusters provides an opportunity to study the home spiral's framework.

Start the tour with a description of the Milky Way and our place in it. The Milky Way is a mid-sized spiral galaxy whose immense disk spans more than 100,000 light-years. Though broad, on average it's just 3,000 light-years thick. The disk includes the graceful spiral arms that curve outward from a small bar piercing the galaxy's center. The arms contain relatively young stars and hold the giant gas clouds that churn out new suns.

Surrounding the galaxy's center is the so-called bulge, a core of older, yellowish stars. The disk and bulge are encapsulated within a huge halo of old stars and globular star clusters that stretches 300,000 light-years from the center. The whole thing floats within a vast halo of unseen dark matter, many times larger and more massive than all the visible parts of the Milky Way.

To help illustrate the galaxy's basic structure, try making your own galaxy. All you need are four old CDs, a half-inch Styrofoam ball, a knife, and a hot glue gun. Start by gluing together the CDs, printed sides inward. Fill the hole in the center of your CD stack with hot glue. Then cut the Styrofoam ball in half and place one piece over the glue-filled hole on each side of the CD/galactic disk. Voilà! An instant model of the Milky Way Galaxy.

With your galactic model in hand, point out the naked-eye structure of our home spiral. Explain that the solar system sits inside the disk, about halfway out from the center (some 26,000 light-years). Because Earth lies inside the Milky Way, the spiral arms look like a band of stars that circles the sky. Here's where the model comes in handy. Hold your makeshift galaxy low enough to look down on it. From this top-down perspective, the disk and its spiral arms come into view. If you hold the model edgewise, the galaxy appears to be a thin straight line with a bulge on either side. This line is the galaxy's thickness, while the lumps made by the Styrofoam ball form the central bulge. In the night sky, that "lump" is in the direction of Sagittarius the Archer, who looks like a teapot.

Sagittarius is a good place to begin scanning the summer Milky Way with the unaided eye. Here you'll find the Large and Small Sagittarius star clouds, as well as many deep-sky binocular objects. Following the Milky Way northward leads to the Scutum Star Cloud and then into Aquila the Eagle.

At this point, a dark band called the "Great Rift" becomes obvious. It stretches from the star Deneb in Cygnus all the way to Centaurus in the southern sky. The Great Rift is an interstellar dust cloud that blocks the light from stars shining beyond it. These dust clouds are generally found on the inner edges of spiral arms; they're also where most of the new stars are forming.

Once you've taken in the summer Milky Way with the naked eye, get out a pair of binoculars. A modest pair easily shows many targets. Sagittarius alone holds objects such as the Lagoon (M8), Trifid (M20), and Omega (M17) nebulae and open clusters such as M18, M21, M23, and M25.

Cygnus is another fine place to scan for Milky Way treasures. The brightest section, called the Cygnus Star Cloud, lies between the stars Beta (β) and Gamma (γ) Cygni. The North America Nebula (NGC 7000) near the bright star Deneb is another good target, and this one even offers a chance to do a bit of geography on the side.

If you seek a binocular challenge, try the Veil Nebula (NGC 6960 and NGC 6992–5). Its faint gossamer wisps can be spotted in a pair of 7x50 binoculars.

When Galileo first pointed his modest spyglass toward the "River of Milk" in 1610, he described it as "an immense number of stars." Views of the Milky Way's vast and dense star clouds can have a profound effect on a curious young child. Foster that curiosity. Take your favorite youngster on a tour of the home spiral. — *Andrea Gianopoulos*

Glowing gas clouds, rich star clusters, and dark dust lanes highlight the Milky Way in the direction of the galaxy's center in Sagittarius.

Inset: The Great Rift cleaves the summer Milky Way, starting near Deneb in Cygnus (upper left) and running through Aquila and beyond.

Jerry Lodriguss / Inset: Chris Cook

FUN FACTS

To Native American Seminoles, the Milky Way is the path that leads good souls to heaven. To the Norse, it's a road leading to Valhalla, while Chinese and Arab myths represent it as a river. The name Milky Way comes from the ancient Greeks and their belief that the band was a spray of milk, or "gala," from which the word galaxy originated.

The Milky Way's center lies in a direction roughly 5° west-northwest of Gamma (γ) Sagittarii, the star that marks the point in the teapot's spout.

It takes 200 million years for the sun to complete one revolution around the galactic center. The last time the solar system occupied its current spot, Earth was in the age of reptiles and continental breakup.

LUMICON® High Performance

20 Years of Innovation!

Visit our web site: http://WWW.LUMICON.COM

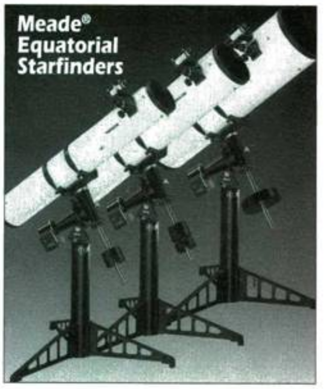
MEADE®Equatorial & Dob Starfinders

Meade Dobsonians 6 -16"

6"f/8 Dobsonian Starfinder ($46P&S)	$349
6"f/8 Equatorial Starfinder ($79 P&S)	$649
8"f/6 Dobsonian Starfinder ($59P&S)	$449
8"f/6 Equatorial Starfinder ($89 P&S)	$749
10"f/4.5 Dobsonian Starfinder ($85P&S)	$599
10"f/4.5 Equatorial Starfinder ($99 P&S)	$879
12.5"f/4.8 Dobsonian Starfinder ($95P&S)	$895
16"f/4.5 Dobsonian Starfinder (frt. COD)	$1195
16"f/4.5 Equatorial Starfinder (frt. COD)	$2695

*All Starfinder telescopes shipped directly from Meade to the purchaser. Please add the indicated packing and shipping charge to the price. Slightly lower P&S for payment by check. Lumicon showroom prices are $50 to $100 higher.

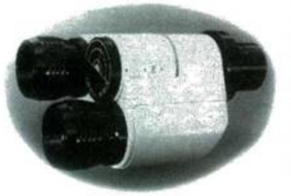
See the Meade ad in this magazine for full descriptions. Starfinders are complete telescope systems with motor drive and finderscope (Equatorial only) and 25mm (48x) eyepiece. New DC motor runs on four AA batteries.



ACCESSORIES

Magellan computer, specify Dob or Equatorial ($15 P&S) $285; **Lumicon 1¼" UHC or O-III** Filter $99.50. **Vinyl covers** to keep dust free (2 req.) for **6" - $10**; for **8" - $15**; for **10" - $20**; for **16" -$35**.

New LUMICON® binocular viewer



The new LUMICON Binocular viewer is judged to be equal or superior to even more expensive binoviewers. Custom made for Lumicon, these exquisite German-made units have the highest image transmission (91%) Threaded for filters. Both planetary and deep-sky viewers will be impressed. Ideal for Schmidt-Cassegrain telescopes. **$749.⁰⁰**

Adjustable piggyback mount

LUMICON's piggyback mount is ideal for telescopes of 6-16" aperture. It permits both vertical and sideways adjustment for optical alignment. Also ideal to mount LUMICON 80mm SUPER-FINDER, large telephoto lenses and small telescopes up to about 5 lbs.

Lumicon Adj.Piggyback Mount $59.50

Specify telescope size: 6", 8", 10", 11", 14", 16":

H-ALPHA pass filter

Yields spectacular contrast gains in B&W photography with telephoto lenses. Yields pinpoint star images. Superb with hypered 2415. For color, use the LUMICON Deep-Sky (DS) filter.

Specify Lens Size	**H-Alpha**	**DS**
46,48,49mm	$59.00	$199.50
52,55,58,62mm	$69.00	$199.50
67,72,77mm	$79.00	$399.50
82mm (77mm+adapter)	$89.00	$415.00

Hypered 2415 film, 36 exp $11.95

Lots of Adapters

2" adapter for C-8 Meade 2080, etc.	$29.50
2" adapter for C-80, C-100 refractor	$39.50
2" adapter for C-70, C-80F, C-102F fluorite	$39.50
2" adapter for C-6, Comet Catcher, Meade 395	$30.00

Extension Tubes

1" long 1¼" OD thread-in extension	$12.00
2½" long extension (holds 1¼" filters)	$19.50
4½" long extension for 1¼" eyepieces	$29.00
3" long extension for 2" eyepieces*	$29.00
2" long extension for 2" eyepieces*	$29.00

Viewing Adapters

2"\1¼" reducing bushing, thread 48mm*	$25.00
2" T-thread adapter, threaded 48mm*	$25.00
T-thread 1¼" adapter	$25.00
F/10 2" or 1¼" eyepiece viewing adapter for Giant Easy-Guider	$59.50
Low profile star diagonal eyepiece holder	$16.00
Meade 2" diagonal /Giant Easy-Guider	$39.50

**threaded to hold 48mm filters*

Meade SCT & Maks 3.5"-16"

NEW! 3.5 f/14 ETX Maksutov ($20)	$595
ETX, showroom price (no long wait)	$615
8"LX10 w/wedge, hand controller ($65)	$995
Field Tripod for 8" LX10 ($20 P&S)	$195
8" LX50 w/wedge ($115 P&S)	$1395
Adj. tripod for 8-10" SCT ($30 P&S)	$295
8" LX200 w/computer ($65 P&S)	$2795
Wedge for photographing w/8" LX200	$139
7" LX50 f/15 Maksutov w/wedge ($125 P&S)	$1795
10" LX50 f/10 w/wedge, dec. motor, hand controller ($155 P&S)	$1695
10" LX 200 w/ computer ($155 P&S)	$3195
12" LX 200 (f/10 only) ($215 P&S)	$4495
SuperWedge for photo. w/10", 12" LX200	$395
16" LX200 f/10 w/tripod ($385 P&S)	$14,950

LX50 – includes dec. motor, hand controller.
LX 200 - full computer control w/64k mem.
Tripod: Extra for LX 50; included for LX200

Note: Wedge is not needed for visual observing with the LX 200. Select f/10 or f/6.3 (no extra charge) for LX 200.

PHOTOGRAPHY ACCESSORIES

Cassegrain Easy-Guider 4"-8" f/6 or f/10	$249
Giant Easy-Guider for 10"/12" f/4-f/10	$395

Dew Shields 8" ..... $119 10" $129
12" ... $189 16" $289

Takahashi

Telescopes and accessories. 10% off!
Call for details

Low Profile Focusers

Select your desired base plate shape: Coulter Odyssey (thread on installation), Flat 7", 9½"OD, 12½"OD, 16"OD, 21"OD.

Lumicon 1¼" Helical Focuser	$69.50
Lumicon 2" Helical Focuser (1½" high)	$85.00
2" Astro systems focuser (only 2"high)	$149.00
2"/1¼" adapter w/48mm filter threads	$25.00
2" LUMICON Easy-Guider™	$189.50

LED flashlight $14.⁹⁵

This red LED flashlight preserves night vision. 2 AA cells (incl.) will last 60 to 100 hours.

Lumilite™ red LED flashlight	$14.95
Starlite™ adjustible red LED flashlight	$24.95
Skylite™ adjustible white/red LED	$29.95

Large UV/Dust Seal

Protect the optics of your 8-14" Schmidt-Cassegrain with a UV/Dust Seal.

Deep-Sky filter/dust seal for C-8, 2080	$199.50
UV/Dust Seal for Celestron C-8	$39.00
UV/Dust Seal for Meade 4"-8"	$39.00
UV/Dust Seal (lg.) for Meade 10"-12"	$89.50
UV/Dust Seal for Celestron 11"-14"	$89.50

EYEPIECES

Pentax 65° XL

Amazing performance! All have 20mm eye relief, adjustable helical eye guard, super multi-coatings, E.D. Glass

5.2mmF.L., 65°Apparent Field 1¼"	$279
7mm F.L., 65° Apparent Field 1¼"	$279
10.5mmF.L., 65°Apparent Field 1¼"	$269
14mm F.L., 65° Apparent Field 1¼"	$269
21mmF.L., 65°Apparent Field 1¼"	$269
28mm F.L., 55° Apparent Field 1¼"	$259
40mmF.L., 65°Apparent Field 2"	$299

New Lower Prices

Tele-Vue

4X Powermate for 2" eyepieces	$265
5X Powermate boosts magnification 5x	$168
Ranger 70mm f6.8 apchromat w/45° diag.	$695
Pronto 70mmf6.8 w/45° erecting prism	$925
Tele-Vue 85,85mm f/7 APO telescope	$1995
Bino-Vue binocular w/2x correc.	$1030
Gibraltar mount with ash wood tripod	$530
8,11,15mm Plossl . $82 — **20,25mm**	$95
32mm Plossl, widest true field in 1¼"	$110
55mm Plossl, widest possible field	$230
2.0x or 3.0x Tele Vue Barlow Lens	$105
2" Giant Barlow – 2x	$168
4.8mm Nagler 82° field, 1¼" eyepiece	$175
7mm Nagler, 1¼" eyepiece, 82° field	$220
9mm Nagler, 82° field 1¼" or 2"	$240
12mm Nagler Type 4, 82° 1¼" or 2"	$340
16mm Nagler Type II, 82° 2" only	$310
2" Paracorr visual coma corrector	$235
3,4,6,8,10,14mm Radian,60° field	$228
15mm Panoptic 1¼", 68° field	$210
19mm Panoptic 1¼", 68° field	$240
22mm Panoptic 1¼"/2", 68° field	$280
27mm Panoptic 2", 68° field	$330
35mm Panoptic 2", 68° field	$365

Note: TeleVue warranty may not be valid outside USA

Dust Covers

Protect your valuable telescope optics eyepieces and accessories with these black vinyl covers. Add $1 shipping. Deduct 10% for 2 or more sets.

1¼" O.D. plug, seals focuser .... 4/$2

2" O.D. plug	2/$2	3½" O.D. plug	$1.50
1¼", 1⅜"	3/$2	7½"	$10
1½"	2/$2	9½", 10.4"*	$15
2"	2/$2	12½",12⅞"*	$20
2⅛"	2/$2	15", 15.6", 16"*	$28
5½"	$6	19" (DS-16)	$35
*Fits Odyssey		21" (Odyssey-II)	$35

2" Deluxe Barlow

LUMICON 1.8x Multiplier Lens $259.00

LUMICON

21115 Research Dr. #5A, Livermore, CA 94550
Phone Orders: Call our toll free order line: 1-800-767-9576
EXPERT Information: Call 1-925-447-9570
FAX 1-925-447-9589 • Write for FREE Lumicon products catalog

Telescopes and Accessories

ORDER TOLL FREE
1-800-767-9576

2111 Research Drive, Suite 4/5, Livermore CA 94550 ▪ Phone hours: M-F 9AM/5PM pst Sat. 9AM/1PM

Lumicon 50mm & 80mm
SUPER FINDER

Visual astronomers prefer the **LUMICON 80mm Super-Finder™,** since hundreds of deep-sky objects, including most Messier objects, are visible directly. Super-Finders™ also make nice small portable telescopes. 80mm aperture, F=300mm coated achromat: or 50mm, F=200mm coated achromat. Eyepieces and/or star diagonal are extra.

1$^{1/4}$" **50mm** finderscope or 45° version	$69.50
1$^{1/4}$" **straight-thru 80mm** superfinder	$199.50
1$^{1/4}$" **right angle 80mm** superfinder	$209.50
1$^{1/4}$" **right angle** version, w/ star diagonal	$249.50
25mm cross-hair 1 $^{1/4}$" eyepiece (12X)	$59.00
Large mounting rings for 80mm finder	$55.00
1$^{1/4}$" **star diagonal**	$49.00
Mounting brackets, 50mm finder	$39.50
1$^{1/4}$" **45°** diagonal /correct left-right views	$49.00
1$^{1/4}$" **90°** Amici diagonal, correct l/r views	$59.50

Celestron Telescopes

Celestar-8	$1159
Ultima 8"	$2750

Call for best prices on all model Celestron telescopes., including Schmidt-Cassegrains, Dobsonians and refractors.

Enhanced Mirrors Boost Telescope Performance

1.32"	$39.50
1.83"	$49.50

90° star diagonals with 96% reflectivity enhanced aluminum mirrors in a CNC machined black anodized aluminum body. Performance far exceeds prism diagonals.

1 $^{1/4}$" **(1.32" mirror)**	$99.50
2" (1.83" mirror) (see photo above)	$189.50

SKY VECTOR™ $299!!!

Includes Computer, Encoders, Hardware

NGC-Sky Vector™
OFF ON
DIM
MODE
ENTER
UP
DOWN
LUMICON®

LUMICON Sky Vector Features:

- "GUIDE" mode leads you to object
- Digital right ascension readout to 1 min.
- Digital declination reading to 10 arc/min.
- 4000 pulse (0.09 accuracy) encoders
- Polar Alignment NOT REQUIRED!
- Motor drive NOT REQUIRED!
- Just two stars to align
- Works Equally well for alt-azimuth telescopes like Coulter Odyssey and equatorial mounts like C-8, Meade 2080.
- No need to enter latitude, longitude etc.

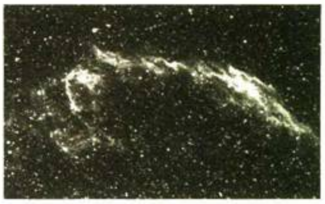
SKY VECTOR I™ **$299.00**
NEW! With over 220 object memory including the 110 Messier and 58 best NGC objects.

SKY VECTOR II™ **$349.00**
Over 3600 objects! Also included planets and full visual descriptions.

Specify Telescope Type: Meade 4",8", 10",12" SCT, C-8, C-11, Odyssey 8", 10", 12", 17 $^{1/2}$" alt-azimuth; Meade 6"-16" Dobsonian. Ultima 8", 9 1/4", 11", add $25 C-14 add $75.

NGC-SKY VECTOR™ **$439.00**
12,000 objects! PC serial port NGC Sky Vector with IDENTIFY (Sky Tour) mode; 12,000 object memory including the corrected RNGC catalogue, IC catalogue, P&K planetary catalogue and much more.

LUMICON FILTERS - BEST IN THE WORLD



AMAZING O-III FILTER™
"The LUMICON O-III proved to be our favorite . . .it gave the greatest contrast gain."
ASTRONOMY, February 1991

Greatly Enhanced Detail
"Consistently performed well on all emission and planetary nebulae. Detail and structure were greatly enhanced in more than two dozen objects I viewed." *SKY & TELESCOPE, July 1995*

Better than a Dark Sky Site?
"From my light-polluted backyard, the view was better with my O-III than with any other filter tested. The view was even better than without the filter from a dark-sky site." *SKY & TELESCOPE, July 1995*

See The Horsehead!
"LUMICON's H-Beta Filter will show subtle features in emission nebulae that others fail to reveal. It can't be beat for the elusive Horsehead and California Nebulae." *SKY & TELESCOPE, July 1995*

Deep-Sky Filter™
BEST for Astrophotography!
"Stunning is all I can say," says noted astrophotographer Jack Newton. Great for both color and black and white photography.

Best Wide-Band Filter!
"Based on our tests, we'd recommend a LUMICON Deep-Sky and Oxygen III as complementary filters. The LUMICON Deep-Sky Filter clearly had the best contrast for reflection nebulae." *ASTRONOMY, February 1991*

LUMICON Multiple Filter Selector, holds 5 $^{1/4}$" filters	$129; $99 if ordered w/filter
1$^{1/4}$" **LUMICON DEEP SKY Filter** threads into most 1$^{1/4}$" eyepieces	$99.50
48mm LUMICON DEEP-SKY Filter threads into most 2" eyepieces. Also fits EASY-GUIDERS	$199.50
2" LUMICON DEEP-SKY Filter threads into most 2" eyepieces. Also has male & female camera T-threads for prime focus photography	$199.50
72mm LUMICON Giant DEEP-SKY Filter (62, 67, 77mm adapter, $10, 82mm $16)	$399.50
2" Rear Cell Filter, fits SCT's ... Deep-sky, $199.50 UHC,O-III, H-Beta	$199.50
1$^{1/4}$" **LUMICON UHC Filter** threads into most 1$^{1/4}$" eyepieces	$99.50
48mm LUMICON UHC filter fits most 2" eyepieces	$199.50
Choice of any two LUMICON filters (save 7%) .... 1$^{1/4}$" $185.00 ... 48mm	$370.00
LUMICON H-Beta Line Filter (9mm bandpass at 486nm) for the California Nebula, Horsehead Nebula ,and other extremely faint nebula. ... 1$^{1/4}$" $99.50 ... 48mm	$199.50
Oxygen-III Filter for very faint planetary and defuse nebula, 11nm bandpass at 496nm and 501nm O-III lines. ... 1$^{1/4}$" $99.50 ... 48mm	$199.50
Lumicon Comet (Swan Band) FIlter ... 1$^{1/4}$" $99.50 ... 48mm	$199.50
Universal Adapters for 1$^{1/4}$" filters. Adapts the filters to any 1$^{1/4}$" eyepiece	$19.50
Universal Adapter for 48mm or 2" filters. Allows use of any 1$^{1/4}$" eyepiece	$25.00

Deep Sky Astrophotography | PPF 400 NEW FILM

LUMICON Easy-Guiders™*

Guide off-axis to make lovely astrophotos. All LUMICON Easy-Guider™ off axis guiders have both radial and 360° rotational adjustments for 5x easier guide-star selection, use 48mm filters, 360° camera rotation, large prisms for bright guide stars. Specify camera and telescope type.

NEWTONIAN Easy-Guiders

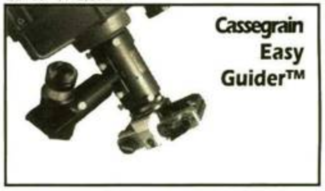
NEWTONIAN Easy-Guider	$189,50
48mm coma corrector/field flattener	$285.00
1.8X multiplier (2" Deluxe Barlow)	$259.00
3x relay diagonal	$99.50
Illuminated recticle eyepiece, pulsed	$119.50
Guider for Hasselblad	$489.00
Guider for Mamiya 645	$259.00

CASSEGRAIN Easy-Guiders
for C-8, Meade 2080, Cynamax 8, includes 50mm achromatic lens for f/6 operation (3x shorter exposures!). Superb rich field viewing too.

Cassegrain Easy-Guider	$249.00
Adapter for Hasselblad	$299.00

Mamiya 645 $119; Pentax 6x7 add $129, Pentax 645 add $149.

*US Pat. 4,448,500



GIANT Easy-Guider
For Celestron 11, C-14 and the 10"-12" Meades. Includes 80 mm clear aperture achromatic lens for edge-to-edge illumination & pinpoint star images. f/ratio adjustable f/4 to f/11. Also yields unmatched rich-field viewing.

Giant Easy-Guider	$395.00

Adapter for Hasselblad $399; Mamiya 645 $149; Pentax 6x7add$139; Pentax 645 add $159.

48mm Deep-Sky Filter ordered with any Easy-Guider, (save $20)	$179.50
Illuminated recticle eyepiece	$119.50
Cable Release	$9.95
Declination motor (state scope type)	$109.00

Film Hypersensitization Kits*

LUMICON Hyper-Kits™ yield 3-15x film speed gain in long exposures. They are safe and simple to use. Easy Hyper-Kit™ includes a chamber with all controls and fittings, thermometer, a refillable cylinder of non-flamable forming gas and a hand operated vacuum pump. **US Pat. 4,473,636*

Model 300 Hyper-Kit sensitizes any 35mm film in hours. Best for 2415. Achieves highest possible film speeds	$325
Model 600 Hyper-Kit Like the Model 300, but also sensitizes 120/220 larger film and small glass plates.	$395
Model 1200 Hyper-Kit is for 4x5" plates and film up to 5x7" . Has 2 gas cylinders & temperature controller.	$595
Temperature controller for any kit	$75
Electric Vacuum Pump, Model R-10	$325

Try PPF Hypersensitized Film

LUMICON Hypersensitized film: essential for good deep-sky astrophotography. (Deduct 10% for 3 or more rolls.)

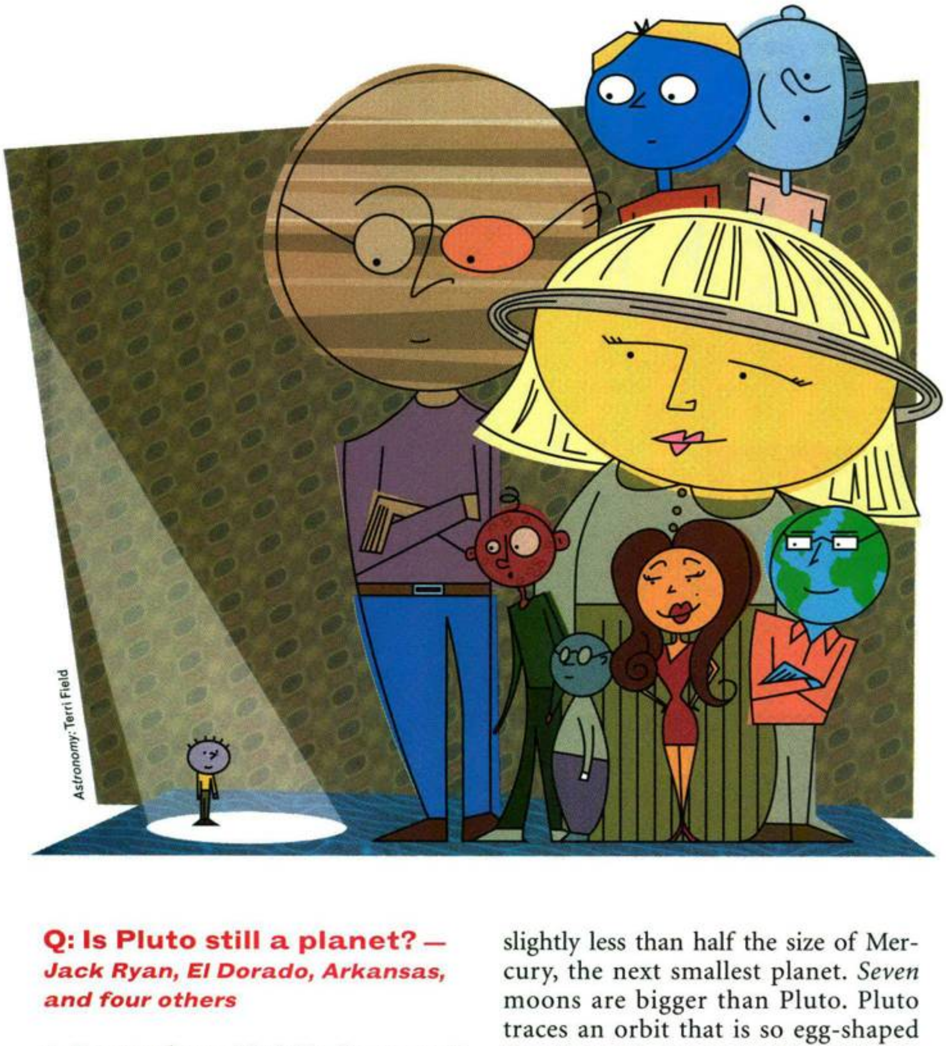
Kodak PPF-400 THE BEST!, 36exp.	$14.95
2415 Ultrafine B&W, red sensitive, 36 exp.	$13.95
Kodak Gold 1000 fast, fine grain, 12exp.	!3.95
Fuji G800 Fine Grain color neg. 24 exp.	$13.95
Ektachrome1600, fast slide film, 24 exp.	$19.95
Fujichrome RD 1000, fine grain slide, 24 exp.	$12.95
D-19 B&W Developer, 1 gal.	$8.50

Meade & Celestron

Lumicon carries a full line of
Meade & Celestron Telescopes & Accessories
All at competitive prices & with FAST delivery
California residents add 8.25% sales tax

ask Astro

Pluto, Photography in Space, Black Holes



Astronomy: Terri Field

Q: Is Pluto still a planet? — *Jack Ryan, El Dorado, Arkansas, and four others*

A: To paraphrase Mark Twain, news of Pluto's demise has been greatly exaggerated. According to the International Astronomical Union (IAU), which is the official arbiter in such matters, Pluto is still a major planet. Despite media reports to the contrary, the IAU has no plans to remove Pluto from the realm of planethood.

Still, some astronomers question Pluto's status as a major planet, and they summon a litany of arguments to support their cause. With a diameter of only 1,470 miles (2,360 km), Pluto is slightly less than half the size of Mercury, the next smallest planet. *Seven* moons are bigger than Pluto. Pluto traces an orbit that is so egg-shaped that it spends 20 years of its 248-year orbit closer to the sun than Neptune. And unlike the orbits of the other planets, Pluto's orbit is significantly tilted to the plane of the solar system.

Pluto's detractors also cite the fact that Pluto has plenty of company in the frigid realm beyond Neptune. In just the past 7 years, astronomers have found more than 90 small, icy trans-neptunian objects. Just like Ceres, the largest asteroid, Pluto isn't big enough to sweep out small bodies in its region of space. To the would-be demoters, Pluto has a lot more in common with the other trans-neptunian objects than it does with the eight other major planets, and if it had been discovered in the 1990s instead of in 1930, it would have been classified as a trans-neptunian object.

But Pluto's defenders raise equally compelling arguments. Pluto has an atmosphere and a large moon. It's big enough so that gravity shapes it into a sphere. If Earth had a tilted, elongated orbit, it would still be considered a major planet. Jupiter is 11 times bigger than Earth in diameter, yet Earth is only five times bigger than Pluto, so a creature living on Jupiter might not consider Earth (and Mercury, Venus, and Mars) a major planet. And like Pluto, Earth has thousands of small bodies that come into its neighborhood — the near-Earth asteroids. Pluto also has history on its side. After all, who wants to rewrite thousands of astronomy books?

Ultimately, it's a question of semantics. Until astronomers agree on a definition of exactly what makes a planet a planet, the debate will rage on.
— *Robert Naeye*

Astronomy would like to hear whether you think Pluto should be considered a major planet.
Visit our website at
http://www.astronomy.com
to register your vote.

Q: Why is it that photos and videos taken from the space shuttles never show any background stars when the background is the void of space? — *Robert H. Scott, Skull Valley, Arizona*

A: When astronauts take pictures in space, they are usually photographing brightly lit objects such as the space shuttle, Earth, or other astronauts. If they are on the daylight side of Earth, those objects are exposed to full

HEADQUARTERS For ETX Accessories

JMI has developed accessories nobody else has!

90/EC Compatable
ETX-90/EC
90/EC Compatable
HANDY EYEPIECE STORAGE
90/EC Compatable

Piggy-Back Camera Mount with Counterweight
$59.95 ($6)

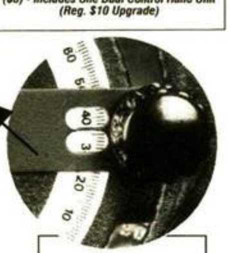
Get fast Polar alignment with JMI's NEW ETX "POLAR FINDER" Sight tube
Easy to install
$49.95 ($5)

90˚ FINDER CONVERSION KIT
Converts Straight Through to 90˚
$69.00 ($5)

MOTOFOCUS
End the focusing wiggles.
$99.95 ($6)

MOTOFOCUS & MOTODEC **$169.90 ($8)**

Order MOTOFOCUS & MOTODEC at the Same Time and Save Big - $169.90 ($8) - Includes One Dual Control Hand Unit (Reg. $10 Upgrade)



LARGE EASY TO READ LATITUDE SCALE

NEW ETX Accessories Video
$10.00 (N/C)

We do not sell ETX scopes
To order JMI accessories,
call 1-800-247-0304.
Visa and MasterCard accepted.

Introducing Commando

New From JMI ETX Motor Drive Command Center

This ultra-compact gear drive moves your ETX with
- improved tracking,
- less back-lash,
- variable-speed slewing to 10 times normal,
- nothing to remove from telescope.
- Slewing in Right Ascension and Declination, plus electric Focusing.
- Fast installation (attaches with one bolt).

The ETX internal tracking motor is never activated. Only works with JMI Tripod, Wedgepod and Wedge or standard legs.

(ETX) Commando **$229.00**

Includes RA Motor and Commando Center. *Save big. Purchase motors at the same time*

DEC Motor **$50.00** (S2)
When purchased with Commando.

MOTOFOCUS **$50.00**
When purchased with Commando.

CALL NOW TO ORDER
1-800-247-0304
Visa and MasterCard accepted.

90/EC Compatable

STURDY EQUATORIAL WEDGEPOD
Ultra Compact
Folds to 23"- Extends to 55"
Adjustable with latitude scale (0° to 90°).
Includes bubble level
Holds 4 Eyepieces and
Meade or JMI Hand Control
Easiest to use - telescope slides into place
so easy you probably won't believe it.
Sturdy yet compact.
Also works great for terrestrial viewing.
$189.00 ($8)

Foam-Lined Carrying Case for ETX
90/EC Compatable

Travel in Style while Protecting Your Investment.

- Professional Die-Cut Foam Lining -Top & Bottom (No cubes to fall out).
- Compartments to hold 5 to 6 eyepieces, barlows, hand controls, etc.
- Compartments to hold a MAX, mini-MAX, micro-MAX.
- Keys included to Secure ETX & Accessories.
- Will not hold JMI Wedgepod or Equatorial Wedge.

Get Organized for Only
$99.95 ($7)

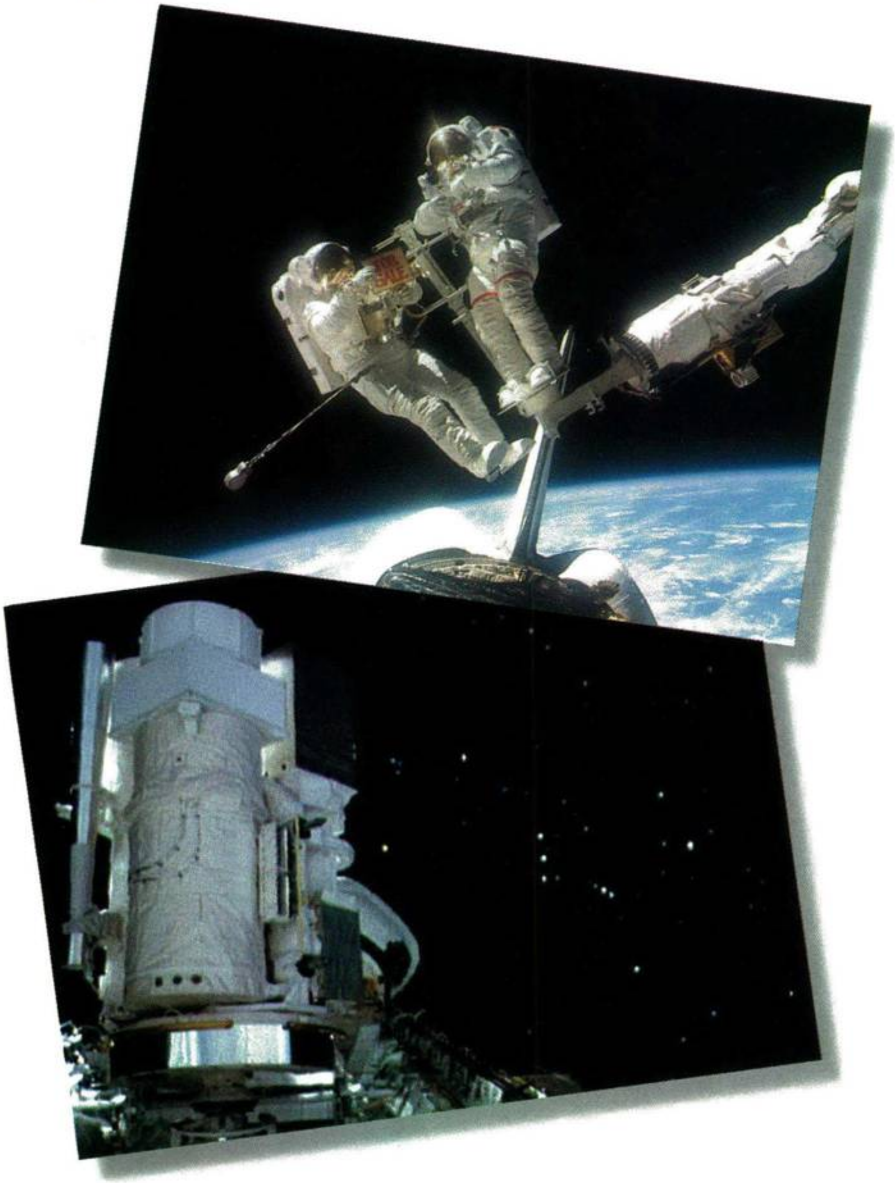
ETX TELESCOPE and ACESSORIES IN THIS CASE
90/EC Compatable
ETX WEDGEPOD IN THIS CASE
90/EC Compatable

HAVE SCOPE WILL TRAVEL

New Wedgepod Foam Lined Carrying Case
$99.95 ($8)

8:00 AM to 5:30 PM Monday thru Thursday – 8 AM to 4 PM Fridays (Mountain Time Zone) – Prices subject to change without notice.

Jim's Mobile Inc. • 810 Quail St. Unit E • Lakewood, CO 80215 Orders: 800-247-0304 • Info: 303-233-5353 • FAX: 303-233-5359



The photo above is typical of those taken in space: Foreground objects and Earth are so bright that stars are lost in the glare. But the familiar stars of Orion can clearly be seen in the photograph below, which was taken from Earth's night side. NASA

sunlight. The photographer must set the camera for a quick exposure of the bright object, but this does not provide enough time to capture the faint background stars. On a few occasions, however, the astronauts take photos when they are on the night side of Earth using a special light-amplification device. In those shots, not only can you clearly see stars above Earth's limb, but you can also watch them rise as the shuttle orbits Earth.

One other point: A few conspiracy theorists claim that NASA faked the Apollo moon landings in the 1960s and 1970s. As "proof," they show that the pictures of the lunar surface show no stars, even though the sky is black. But of course there are no stars in the pictures because of the reasons outlined above. The moral here is don't believe everything you hear— even from people telling you not to believe everything you hear! — *Phil Plait, ACC, Inc. (check out Phil's website at http://www.badastronomy.com)*

Q: Could you please explain why it is possible for a black hole to swallow matter? My understanding is that, from an external point of reference, time stops at the event horizon, therefore it should take an infinite amount of time for anything to cross it. — *James Goldfuss, Seven Springs, North Carolina; Mike Laine, Seattle, Washington; and Peter Buxton, Victoria, Australia*

A: This is one of those fascinating "frame of reference" questions from Einstein's theory of relativity. To an external observer viewing a particle falling toward a black hole, the particle falls faster and faster as gravity pulls it down the drain. But because a black hole warps the fabric of space-time in its immediate vicinity, as the particle approaches the black hole's outer boundary, or event horizon, the observer sees the particle slow down and eventually become frozen in time at the horizon. The particle never appears to make the fatal plunge across the horizon. For this reason, scientists years ago often referred to these objects as "frozen stars." That was before 1968, when Princeton physicist John Wheeler came along and coined the term "black hole."

But if the particle itself had consciousness, it would experience no unusual time effects as it approached and crossed the event horizon. What the particle would experience as a few seconds, an external observer would experience as billions of years.

But even though an external observer would never see matter falling into a black hole, black holes are still black (discounting black hole "evaporation"). Why? As matter falls toward a black hole, it gets caught in the warped space-time. Just outside the event horizon, an infalling particle would be seen by an external observer to suffer from extreme time dilation. It would take an infinite amount of time for any light emitted by the particle to reach the outside world. — *Robert Naeye and Richard Talcott*

Shutan: Your One-Stop ETX Shop!

Eyepieces!

Meade:

Super Plossl- 52°		
9.7mm	129x	$80
12.4mm	101x	80
15mm	83x	80
20mm	63x	80
32mm	39x	100
40mm	31x	100
Super Wide- 67°		
13.8mm	91x	140
18mm	69x	150
24.5mm	51x	180
Ultra Wide- 84°		
6.7mm	187x	200

Call for others!

TeleVue:

Plossl- 50°		
8mm	156x	$82
11mm	114x	82
15mm	83x	82
20mm	63x	95
32mm	39x	114
40mm	31x	114
PanOptic- 68°		
15mm	83x	210
19mm	66x	240
Nagler- 82°		
7mm	178x	220
9mm	139x	240
Zoom	52x-156x	214

New! ETX-90/EC

$349^95* *Has 4-speed Dual-axis drive!*

Optional Autostar control provides LX200-type ***GO TO*** *slewing to 12,000 objects!*

* With trade-in of your standard ETX-- call or visit web site for details. Price without trade is $599.95 plus S/H.

Meade Accessories:	90/EC	Astro	
Autostar GO-TO drive #497	x		$150
Ac adapter 110 volt #541	x		35
Case- hard #774	x	x	100
Case- soft	x	x	42
Car cord 12 volt #607	x		27
Electric focuser #1244	x	x	120
Finderscope 8x25 right-angle #825	x	x	50
Hi-latitude leg 44-66°		x	30
Interface cord #505	x		call
Low-latitude weight #1422	x		call
Tripod- table leg set/4 #880	x		30
Tripod- Alt-Az field #882	x		call
Tripod- deluxe equatorial field #883	x	x	200

NOTE! *Most accessories listed on this page will fit both models. Please call if you have any questions regarding compatibility.*

Pre-Owned ETX's

From **$349^95**

Includes finderscope, 26mm SP, table tripod, all caps, covers, wrenches, and instruction book!

Original Astro Version

***6 Month** Parts & Labor Warranty!*

45° Prism

$50 Mounts to rear of ETX and provides a corrected image for land viewing.

2x Barlow

$50 Multi-coated and under 3 inches long. Weighs just 4 ounces.

APO 2x

$79 3-element Apochromatic! Shorty design, only 2.75" long and just 5 oz.

Custom Fitted Hard Case

$100 Hardshell case with pre-cut foam interior to precisely fit your ETX. Holds tripod legs, 5 eyepieces, and more! 13x17x7".

Lithium AA

3/$10.50
8/24.00
Powers your ETX 4 times longer than alkaline-AA's.

Moon Filter

$18 Preserve your night vision. Threads to back of 1.25" eyepieces.

Solar Filter

$70 Machine polished Glass filter. Triple coated. Anodized aluminum cell.

90°/Right-Angle Finderscope! Using the standard straight-thru finder can be difficult. Upgrade to this finder today! *CALL FOR PRICE*

Plossl Eyepieces $50 ea. 2/$90
Choose from 7.5mm, 10mm, 12.5mm, 17mm, or 20mm
32mm/40mm $75 ea. both/$130

Deluxe Soft Case

$79 Features padded contoured shoulder strap. Full length front pocket has 5 inner pouches for accessories. Thick padding on all sides and bottom. Zippered top plus rain flap. Water-resistant cordura, 17.5" x 5.5" x 9.5".

Dew Shade

$27 Flexible, felt-lined inside to eliminate reflections. Wraps around tube.

MotoFocus

$99 Variable speed electric focuser. Easy installation. *With MotoDec just* ***$170***

Polar Site

$50 Makes polar alignment easy. Mounts on ETX and folds in for storage.

Piggy Brkt.

$60 Clamps around optical tube and includes a small counterweight.

WedgePod

JMI
$190
Built-in wedge and storage for 4 eyepieces. Weighs 8lbs. Adjusts 22-52".

Field Tripod

Bogen
$159
Weighs just 8 lbs. Adjusts 27-70". Anodized aluminum.

90° Plug

$1.25 ea. Fits into top 90° opening. Keeps dust and dirt out.

SCT Adapt.

$30 Lets you attach standard Schmidt-Cassegrain accy. onto your ETX.

Tele Ext.

$30 Fits onto visual back (at right). Shorty design. Only 3" long.

Vis. Back

$30 Lets you put any standard 1.25"-barrel accy. into the rear opening of your ETX.

Wide Field

$90 Mirror
$100 Prism
Increases field-of-view by **64%!** Requires visual back shown at left.

T-adapter

$35 Mounts to rear of ETX. Accepts all standard t-rings for 35mm SLR's.

Quickfinder

$40 This Rigel zero-power finder works like a Telrad but is only 1.5"x1.5"x4".

Kwik Focus

$32 All-metal construction. Makes focusing a quick, accurate procedure.

Check out the latest ETX Accessories at www.shutan.com

Call or visit web site for **1999 Discount Catalog!** Check or charge card— **ALWAYS** the same low price! Order by **NOON** for same-day shipment. C.O.D. available, inquire. We ship most accessory orders up to 5 lbs. for just **$6.95** via UPS Ground or **$25** 2-Day Air to most **U.S.** addresses. (Worldwide shipping info at www.shutan.com). When in **Chicago,** visit our **3500 square foot** showroom! Shutan is family owned **and** operated since 1918! *All prices subject to change and do not include shipping/handling.* Copyright © 2/99 SC&V.

SHUTAN
camera & video

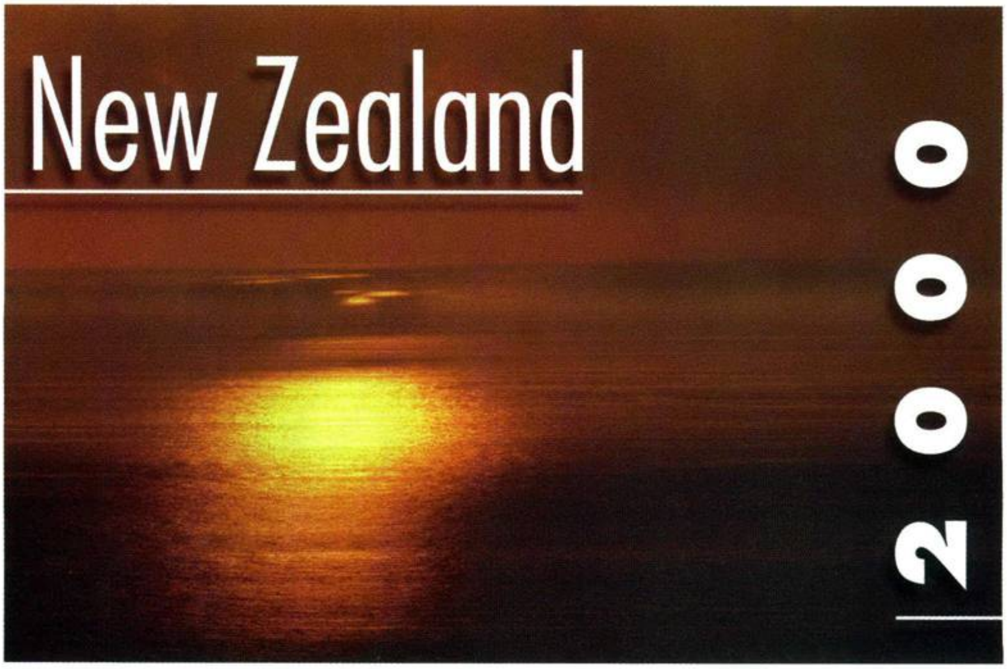
We welcome bids & PO's from Schools!

Toll-Free 800-621-2248
Illinois 312-332-2000 • www.shutan.com
312 W. Randolph • Chicago • 60606

DISCOVER MasterCard VISA AMERICAN EXPRESS
No Surcharge!
M-F 8:30-5:30
Sat 9:00-5:00

Astronomy Magazine presents

The Millennium Tour



Join the editors of *Astronomy* on the Millennium Tour of New Zealand and Australia for New Year's Eve 1999. You can ring in the new year with a 12-day trip to the land down under, and be one of the first in the world to see the first sunrise of the year 2000.

You have two tours to choose from depending on the level of physical activity.
Plus, there's a 5-day extension to Australia that includes snorkeling on the Great Barrier Reef.

Tour One (for a more active itinerary)

- Climb an active volcano
- *Ride the white water rapids*
- Tube through the glow worm caves
- Swim with the dolphins
- And other great adventures

Tour Two (for a more leisurely pace)

- Climb aboard an overnight sailboat in the fjord
- Travel by helicopter to the top of a glacier
- Take a trip on a hot air balloon
- Ride a train ride through the Southern Alps
- And much more

End this century with a memorable trip! Call Specialty Tours for a brochure today! 1-800-677-9412 or (813) 796-7555

783-9810

Astronomy's

Marketplace

Welcome to the MARKETPLACE section in ASTRONOMY Magazine. These pages are specifically designed to be an affordable and highly effective way for you to market astronomy-related products or services. Call Michael Ellis at 888-558-1544, ext. 636 to place your advertising message here.

DURABLE HIGH-QUALITY COATINGS

With our ENDUROBRIGHT™ COATINGS you will get the most durable and pinhole-free front-surface mirror coatings on the market today! GUARANTEED

- QSP's PROTECTED ALUMINUM coating >89%
- QSP's SEMI-ENHANCED coating >92%
- QSP's ENHANCED coating >96%
- turnaround for PAL mirrors less than 12.5" 7 working days
- turnaround for EAL mirrors less than 12.5" 14-21 working days
- SLAR and High-Efficiency AR coatings upon request
- up to 44-inch diameter
- ENDUROBRIGHT™ dielectric coatings upon request

QSP
QSP Optical Technology, Inc.
1712-F Newport Circle
Santa Ana, CA 92705
Phone: 714-557-2299 • Fax: 714-557-2170
http://www.QSPtech.com

ARP *Seeing Red*

Tel./Fax: (514)842-3667 || http://redshift.vif.com

Total Eclipse 1999

View partial phases or sunspots

Flexible Frame Goggles
with #14-density arc-welding glass
Filters out ultraviolet and infrared
light – better than Mylar

$24.95

Includes insurance, shipping, and handling.
Send check or money order to:

EXOTIC EXPEDITIONS
P.O. Box 761
Woodbridge, New Jersey 07095
Fax: 732-855-0042
E-Mail: small.exoticexp@erols.com
Website: www.exoticexpeditions.com

STAR SPECTROSCOPES

FOR TEACHERS AND AMATEUR ASTRONOMERS

See something NEW with your telescope!

Visual Star Spectroscope $149
Visual / Photo / CCD Model $199
Free Brochure
RAINBOW OPTICS
1593 "E" Street, Hayward, CA 94541 (510) 581-8266

Bargain Books

America's *biggest* selection. Save 30% on current books, up to 80% on overstocks. Astronomy, Science, Photography, Nature, Biography—over 60 subject areas.

Free Catalog: 1-800-677-3483

Hamilton 5921 Oak, Falls Village, CT 06031-5005

Solar Eclipse 1999
Turkey

August 7 - 15

• Limited to 25 Participants •

- ➤ **Best safe viewing site on the eclipse path!**
- ➤ **Explore Turkey and its ancient history**
- ➤ **The smallest eclipse group around**

Outer Edge Expeditions
800-322-5235 • 248-624-5140
E-mail: adventure@outer-edge.com

ECLIPSE CRUISE '99

10 Days from London
Primary Observation site, Irish Sea
"Clearest skies in Western Europe."
*Join **BUZZ ALDRIN** and Steve Last*
Exclusive post-eclipse Q & A session for
Travel Wizard guests only.

* 12 days in Turkey also available

For Free Information, write to:

TRAVEL WIZARD
7788 University Ave., La Mesa, CA 91941
1-800-708-7677
(619) 464-1946 • FAX: 462-5278
www.travelwizardtravel.com

CCD IMAGING EQUIPMENT

MORE THAN 6 YEARS EXPERIENCE!

ACCU-FOCUS™ FOR SHARP COLLIMATED IMAGING!

M1 IMAGED WITH SBIG ST8, AO-07, 12.5" R-C TELESCOPE, BYERS MOUNT & ACCU-FOCUS™
© R.BELL, 1998

SBIG CAMERAS
ADAPTIVE OPTICS
MEADE CAMERAS
CELESTRON CAMERAS
ADVANCED APOGEE
CCD DEALER

WHAT IN THE WORLD

PHONE ORDERS TOLL FREE
(888) 942-8967
ON LINE CATALOG
www.whatintheworld.com
P.O. Box 1767 28200 Hwy. 189 #E200
Lake Arrowhead, CA 92352
PH: (909) 337-5080 • FX: (909) 336-9708

ADIRONDACK VIDEO ASTRONOMY

SPECIALIZING IN VIDEO AND CCD IMAGING

New ASTROVID 2000 Video System

- ☆ **ASTROVID CCD Video Imaging Systems**
  ☆ ***Starting at $365***
- ☆ **View the Solar System in Real-Time**
- ☆ **Perfect for Colleges & Planetariums**
- ☆ **Record Images to VCR or Camcorder**
- ☆ **No Computer Required**
- ☆ **Easy to Use!**

Starlight Xpress

- ☆ **Europe's Favorite CCD Cameras**
  ☆ ***Starting at $975***
- ☆ **MX5 Mono 12 Bit or 16 Bit**
- ☆ **High Blue Response**
- ☆ **MX5 One Shot Color**
- ☆ **Only 50mm x 100mm in Size**
- ☆ **More Image For Your Money!**

CCD Imaging Accessories
By True Technology Ltd.

- ☆ **Quickly Find Focus & Center Objects**
- ☆ **Flip Mirror Finder $239**
- ☆ **Flip Mirror Filter Finder............ $329**
- ☆ **Dichroic 5 Filter Tri Color Set...... $179**

CCD Imaging & Atlas Software
☆ **Bruce Johnston SuperFix** ☆ **QMiPS Imaging Software** ☆ **Software Bisque** ☆ **CCD Deep-Sky Atlas by Pedro Ré** ☆ **Deep Sky Imaging Using a CCD Camera**

CCD Imaging Books
☆ **The Art & Science of CCD Astronomy**

Rainbow Optics Star Spectroscope
☆ **Visual/Photo/CCD-Model $199**

ADIRONDACK VIDEO ASTRONOMY
35 Stephanie Ln. ☆ Queensbury, NY 12804 U.S.A.
Toll Free 1-888-799-0107
INFO./FAX: 518-761-0390
http://ourworld.compuserve.com/homepages/AVAastro/

VISA MasterCard

Astronomy's

Marketplace

SHOP ON-LINE

WWW.ASTRONOMYONE.COM

toll free: 888 670 8451
fax: 410 366 6311
email: info@astronomyone.com

BUY Manufacturing Telescopes and Fine Optics since 1991

FACTORY DIRECT & SAVE

- Equatorial Reflectors
- Equatorial Refractors
- Dobsonian Reflectors
- Accessories
- Parabolic Mirrors
- Diagonal Flats

DISCOVERY TELESCOPES, Inc.
615 S. Tremont St.
Oceanside, CA 92054
tel: (760) 967-6598
fax: (760) 967-6798

www.discovery-telescopes.com

ASTRO-PHYSICS

High-quality instruments for discriminating observers and astrophotographers

Refractors- 105,130,155 mm dia.
German Equatorial Mountings
Visual and Photographic Accessories

155 StarFire EDF with 4" Focuser,
900 German Equatorial
80mm Guidescope, accessories

11250 Forest Hills Rd.
Rockford, IL 61115 USA
Ph: 815-282-1513, Fax: 815-282-9847

Moonwalker Autographs

DestinySpace.com

- Space Collectibles -
- Fossils - Insects In Amber -
...And Lots More Cool Stuff! -

T & T Binocular Mounts & Beyond, LLC

Super Side Mount

Designed for comfort it can be used standing or sitting with ease. The heavy duty central towers and stabilized friction plate allow one handed operation while holding even the heaviest 100mm binocuars. $180.00 plus applicable tax, S & H.

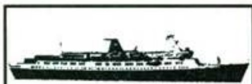
Call or write:
18 Strong St. Extension, East Haven, CT. 06512
(203) 469-2845 or (203) 272-1915

Boeckel's Astronomical Supplies

"We can get your eyes on the skies"

- Full line Celestron Dealer
- Low Prices
- Repair Service Available
- On Site Observatory for Demonstrations
- Friendly Help

Mail Order or Information
Boeckel's
Astronomical Supplies
2155 Greenbriar Rd. York, PA 17404
Mon-Fri 4pm-10pm Sat 10am-4pm EST
Call toll free 1-877-308-1238 or (717) 308-1238
Or Email: BASupplies@aol.com
http://www.basupplies.whowhat.net



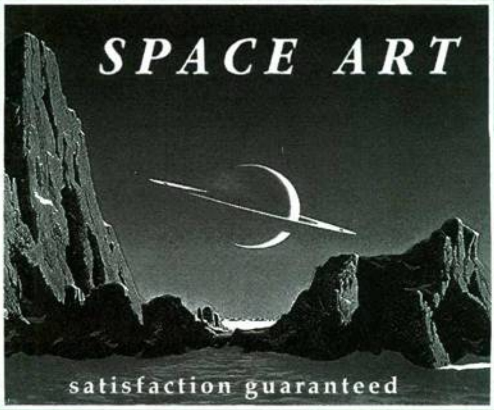
ECLIPSE CRUISE 1999
BLACK SEA AUG. 6-13
LIMITED CABINS AVAILABLE

Join our group aboard the "STELLA SOLARIS" for a CRUISE TO TOTALITY escorted by the top astronomers/astrophotographers in the field!

BEST CRUISES/EXOTIC EXPEDITIONS
CALL TODAY: 1-800-576-2378
E-Mail: small.exoticexp@erols.com
Website: www.exoticexpeditions.com

SCOPE SAVER
BB200 OBSERVING TABLE

The **BB200** is the heart of the ***Scopesaver*** observation station. It fits all ***Meade*** Telescopes that use a standard tripod, including LX200 (7-12"), LX50 (7-10"), 2045D, 2080/2100 (8-10"), all Meade refractors, and some **Celestrons.** The 12x20x1/4" aluminum table is black anodized. A precision cross-check level aligns the tripod prior to mounting the scope. Nylon guides simplify mounting. Keypad registers provide secure, one-hand usage. There are nine 11/4" and three 2" eyepiece holes. Accommodates equatorial wedges and with $10 Keypad kit, Super wedges. **Accessories:** Reference/Laptop table $54; brace Assy. $18; 4 hole 2" eyepiece extension $45; Beverage holder $23; Flashlight holder $9; ScopeSaver Jr. $50. Amex-M/C-Visa. Beigle/Bryant Engineering, 14826 Willow Glen Court, Canyon Country, CA 91351
800 330-8339 805 298-0098 fax 805 298-7776.



PAINTINGS
PRINTS
POSTERS
CARDS

OUR BEAUTIFUL 40-page color catalog $3 USA $5 Int'l

Bonestell McCall Bean Carroll Poor Eggleton Davis Dixon Foster Rawlings Tucciarone Hardy Hartmann Butler Cabrera Hejja Durda Egge *& more*

AUTOGRAPHED ART

Armstrong Glenn Lovell Cernan Bean Conrad Aldrin Shepard Leonov Levy Hale Bopp *& more*

800-727-NOVA
NOVAGRAPHICS
SPACE ART GALLERY

Box 37197-B7
Tucson, AZ
85740

complete selection online ordering
www.novaspace.com

METEORITES!

Irons. Stones. Stony-irons. Tekites.
Quality display and study specimens.
Space jewelry, books, slides.
Authenticity guaranteed.
Color Catalog $2.

Bethany Sciences
P.O. Box 3726-A
New Haven, CT 06525

CATCH A FALLING STAR!

(203)393-3395

Howie Glatter's *Holographic Laser Collimator*
with removable diffractive-optic centering target.
Facilitates alignment and centering of most telescope optics, including Newtonians, Cassegrains, and refractors. Directly centers f/ 2.7 through f/ 35 optics!

Machined from solid aluminum and stainless, accurate to .0002".
No adjustments ever needed- Permanent built in laser module alignment
40 hour lithium battery, case and instructions included. One year warranty.

2"-1 1/4" Holographic Laser Collimator
650nm. - $185
1 1/4"Holographic Laser Collimator
650nm. - $150
For 635nm. laser (brightest red), add $25
Basic single beam collimators still available - $125 & $100
$5 S&H

Howie Glatter 3850 Sedgwick Av. Bronx, N.Y.10463
Tel/Fax 718 796 3203
howieglatter@mindspring.com
Write, call, fax or E-mail for free information.

SINGLES IN SCIENCE

and others interested in science/nature
are meeting through *Science Connection*

800-667-5179
www.sciconnect.com/

TELESCOPE KITS, LENSES, ACHROMATS MIRRORS, MIRROR BLANKS, ALUMINUM COATINGS & ACCESSORIES

BUY DIRECT ★ DO IT YOURSELF

Stock & Custom mirrors and molded mirror blanks, diagonals, parts made from Pyrex, optical glasses, fused silica, quartz and other low expansion ceramic materials. Telescope accessories, do-it-yourself books.

Write, call, fax or e-mail for catalog

NEWPORT GLASS WORKS, LTD.
1629 Monrovia Ave.
Costa Mesa, CA 92627
714-642-9980
FAX: (714) 642-4832
E-mail: ngw@netcom.com
Web: http://www.newportglass.com

TOTAL SOLAR ECLIPSE 3

EXCEPTIONAL EXPERIENCES

Black Sea Cruise
Turkish Land Odyssey
Danube River Journey

Call for **FREE** brochure
800 830-1998
Journeys for Inquisitive Minds

TravelQuest INTERNATIONAL

570 Skyview Drive • Prescott, AZ 86303
Visit our website: www.tq-international.com

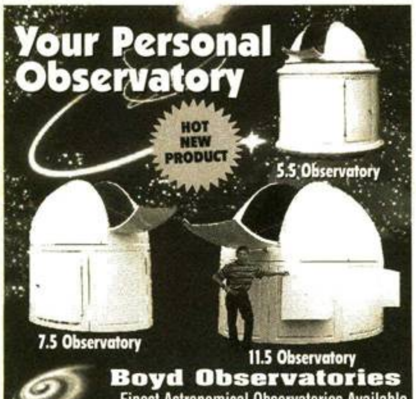
Telescopes

Great Prices
Knowledgeable Staff

(800) 550-7192

THE TELESCOPE STORE

www.telescopes-earth.com



Boyd Observatories
Finest Astronomical Observatories Available
www.boydobservatories.com or call (810) 749-9525

KITES

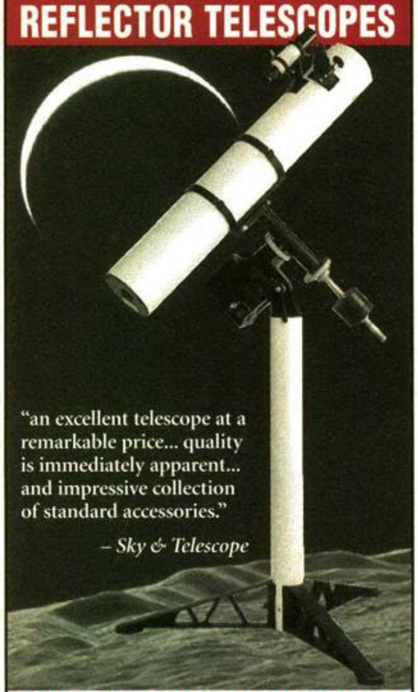
FREE COLOR CATALOG

Choose from over 200 exiting kites.
• Many unusual & innovative designs.
Call or write for your catalog today!
Into The Wind • **(800) 541-0314**
1408-A Pearl St., Boulder, CO 80302

Total Solar Eclipse - August 11, 1999
L&S Astronomy Tours presents a super-economical way to see the maximum duration of totality near Bucharest, Romania. Great weather prospects. Dark skies for nighttime observing.

For more information contact:
L&S Astronomy Tours
P.O. Box 297, Long Beach, NY 11561
Call: 516-889-6607, 516-889-6529
or
E-mail: eclipse99@mindspring.com

OUT OF THIS WORLD REFLECTOR TELESCOPES



"an excellent telescope at a remarkable price... quality is immediately apparent... and impressive collection of standard accessories."

– Sky & Telescope

At Very Down to Earth Prices!

See what you've been missing, from the craters of the moon to the rings of Saturn, with these spectacular 110mm (4.3") and 150mm (6") Newtonians for much less than you'd expect to pay! Diffraction-limited optics, loads of *free* accessories and rugged, all metal construction (even the tube) – old-world quality! Complete with precision-machined German equatorial mount with clock drive on solid metal pedestal with built-in anti-vibration pads. 110mm complete with interchangeable 1.25" eyepieces (15mm Kellner & 25mm plossl), 6x30 finderscope and Barlow lens; 150mm also includes 42mm eyepiece and 8x50 finderscope. Set of six glass filters and tongue & groove wooden storage cases included with each. A real value! One-year warranty; 30-day money-back satisfaction guarantee. Quantities limited.

Just **$499*** *for 110mm; only* **$749** *for 150mm!*

Equatorial mounts, mirrors, eyepieces and accessories now sold separately! Call for details.

SOVIETSKI COLLECTION™
Treasures from a Bygone Era®

CALL *NOW!* 800-442-0002

3450 Kurtz St., #C, San Diego, CA 92110 • Fax (619) 294-2500
http://www.sovietski.com • e-mail: sales@sovietski.com
*Plus S/H • We Ship Worldwide.

Starsplitter Telescopes

Uncompromising Quality Focused on the Customer!
We offer the largest selection of high quality Newtonian Telescopes on the market today!

Starsplitter II
15"- 40"

Starsplitter Tube
6"-10"

Starsplitter Gem
4.5"-8"

Compacts 8"-15"

Designs to meet your observing requirements and budget.
Complete telescopes or structures for your optics.

Call or write for Catalog
www.starsplitter.com

Starsplitter Telescopes
3228 Rikkard Drive
Thousand Oaks, CA 91362
805-492-0489 Phone & Fax

Astronomy's Marketplace

OUT & ABOUT

TRAVEL ADVISORS, INC.

TOTAL SOLAR ECLIPSE 1999

AUSTRIA/HUNGARY
August 6-15, Vienna - Budapest
1699.00 dbl per person.
Land Tour.
Limited space!

OUT & ABOUT TRAVEL ADVISORS
587 Virgina Ave. Suite 3A
Atlanta, GA 30306
800-914-8232 • 404-892-8998
http://members.aol.com/ecli99

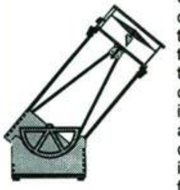
Year 2000 Astronomical/ Scientific Products!

http://www.jensansci.com catalog: $2

6183 Woodland Drive
Grand Blanc, MI 48439
(810) 694-3802

Jensan Scientifics

TELEKIT



Own and build the most complete and advanced truss tube Newtonian telescope kit. Have fun in the process. Many outstanding features included in this easy to assemble telescope. Or, convert your old telescope into a highly portable, full-featured scope.

TK 12.5	**$1100**	**TK 17**	**$1450**	**TK 22**	**$1800**
TK 14.5	**$1200**	**TK 20**	**$1650**	**TK 24-30**	**Call**
TK 16	**$1300**				

Complete truss tube kits WITHOUT optics.

AstroSystems
124 N. 2nd Street
La Salle, CO 80645 USA
http://www.frii.com/~astrosys 970.284.9471 Fax 284.9473

Buy a Star ★ Name a Star

On the exclusive
MSAS Star Atlas
to be placed in our future observatory & science center.
Receive a certificate of record and more.

Free brochure.
Starting at only $30.00 !
VISA/MC accepted

Mtn. Skies Astronomical Society
Box 1169 - LkArwhd, CA. 92352

(909) 336-1699
www.mountain-skies.org

ROGER W. TUTHILL, INC., YOUR ASTRONOMICAL FRIEND, SAYS:

Every Meade ETX-90E/C Scope needs our NO-DU Cap, Solar Skreen, Piggy Back Mount, Field Tripod, User Instructional Video, and our 30mm Right-Angle Finder.

To get your copy of our FREE Sub-Menu Charts & Comprehensive Instruction Book, Send a SASE 9"x12" w/4 stamps to:

Roger W. Tuthill
P.O. Box 1086ES, Mountainside, NJ 07092
www.tuthillscopes.com

Star Hill Inn

an astronomy retreat in the rockies

Experience a unique dark sky vacation. Stay in charming private cottages on hundreds of acres of peaceful pines. 7200' elevation. Star tours, telescopes for rent, or use your own at our observatory. Astronomy, Birding and Art Workshops. Easy access to Santa Fe, Taos, Pecos Wilderness, Wildlife Refuges & Ski Resorts. Open all year. For info:

Star Hill Inn
Sapello, New Mexico, 87745
505-425-5605
www.starhillinn.com

CELESTRON

REFRACTORS

60 EQ Deluxe	$169.00
80 Altazimuth	309.00
80 Wide Angle EQ	299.00
80 Equatorial	349.00
C 80-HD	499.00
C102 HD	669.00

REFLECTORS

4-1/2" Firstscope	$249.00
4-1/2" Deluxe	299.00
4-1/2" Premium	349.00
C114-HD	449.00
6" Star Hopper	439.00
8" Star Hopper	539.00

SCHMIDTS

G3 Maksutov	$499.00
G5 SCT	799.00
C5+ SCT	1149.00
G8 SCT	999.00
Celestar 8	1199.00
Computerized	1699.00
Deluxe	1799.00
Computerized Deluxe	2299.00
Ultima 8 2000	2799.00
G9	1399.00
Ultima 9-1/4"	2499.00
CM 1100	3399.00
Ultima II	2999.00
CM 1400	$5799.00

ACCESSORIES

2x Short Barlow	$45.00
2x Ultima Barlow	75.00
6x30 Finderscope	34.00
9x50 Finderscope	74.00
SCT Piggyback Mt.	34.00
C8 Hand Controller	69.00
SCT T-Adapter	26.00
T-Rings	11.00
45° Erect Diagonal	39.00
90° Erect Diagonal	49.00
Color Filters	14.00
Moon Filter	14.00
6.3 Focal Reducer	129.00
CG4 SA Drive	129.00

EYEPIECES

Plossl 6.3, 7.5, 10mm	$39.00
Plossl 12.5, 17, 20, 26mm	39.00
Plossl 32, 40mm	59.00
Ultima 5, 7.5, 12.5mm	79.00
Ultima 18, 24, 30mm	89.00
Ultima 35, 42mm	109.00
LV 6, 10mm	112.00
LV 5, 9, 15mm	115.00
LV 4, 12mm	120.00
LV 2-5, 20, 25mm	124.00

OTHER

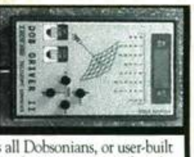
Telrad	$38.00
Laser Collimator	99.00
80mm f5 OTA	169.00

ASTRO STUFF

ORDER TOLL FREE 1-877-REX ASTRO
www.astrostuff.com
TEL: (501) 331-3773 FAX: (501) 331-3131
SHOWROOM HOURS: Mon-Sat 9-6
1903 East Main Street, Russellville, Arkansas 77801

MEADE • ORION • JMI • BINOCULARS

THE AMAZING DOB DRIVER II



Dual axis microstep quartz drive fits all Dobsonians, or user-built equatorials. Powerful computerized tracking, panning, and guiding in the palm of your hand! Super portable, super simple, AC/DC/CAR/BAT 12V. Instant setup–NO ALIGNMENT! Multi-function display. Calibration supertunes your scope to maximum performance. Options for PC link/CCD link.

New Roboscope PC Software
Go to 13,000 + objects + any chart point

Control only - $329 ATM System - $439
Complete system w/ready-to-install drives - $549
Free lit - satisfaction guaranteed!

TECH 2000
3349 SR99 S Monroeville, OH 44847
Ph. 419-465-2997 • Fax 419-465-2484
VISA/MC • WORLDWIDE DEALERS

NEW AUTHORS

PUBLISH YOUR WORK
ALL SUBJECTS CONSIDERED
Fiction, Biography, Religious, Poetry, Children's.
AUTHORS WORLDWIDE INVITED.
WRITE OR SEND YOUR MANUSCRIPT TO
MINERVA PRESS
2 OLD BROMPTON ROAD, LONDON SW7 3DQ, ENGLAND

TryOrbit for Win95

Hands-on approach. You explore and learn as you make any cislunar orbit.

- Generates an animated two-dimensional simulation of each orbit.
- Detailed listing of orbital angles, positions, lengths & speed graphs.
- 75 equations documented.
- 50 graphic illustrations.

Minimum Requirements:

- VGA monitor. Color SuperVGA monitor recommended.
- Windows® 95, or later.
- NT® 3.51, NT® 4.0 or NT® 5.0

Price $29.98. 30 day money back guarantee. To Canada, add 7% GST
Send check or money order to:

Psignologic Services
P. O. Box 34069, Dept. 764
Seattle, WA 98124-1069

Write above for further info & order form.
E-MAIL: timer@axionet.com

SOLAR ECLIPSE 1999
TURKEY

Exciting tour packages by a leading quality operator:

All our tours include guaranteed accommodations at one of the total eclipse sites in Eastern Turkey, plus visits to Cappadocia, Ephesus, and Istanbul.

Superb sightseeing conducted in private air conditioned minibus with participation limited to a maximum of 12 guests per tour to insure comprehensive coverage.

CONTACT "TREASURES OF TURKIYE"

TEL : 1 (800) 572-0526 - FAX : 1(206) 368-9096
E-MAIL: visitturkey@treasuresofturkey.com
INTERNET: www.treasuresofturkey.com

ECLIPSE SHADES™
Safe Solar Viewers
Custom Imprinting Available!

ECLIPSE SHADES
SAFE FOR DIRECT SOLAR VIEWING

Eclipse Shades™ provide the ultimate in protection from harmful Solar Radiation. Lenses made of Optical Grade, Neutral Density 5 Mylar, filter out 100% of Ultra-Violet, 100% of Infra-Red, and 99.999% of Visible Light.

Quality Paper Eyewear & Specialty Optics
Rainbow Symphony, Inc.
6860 Canby Ave. #120, Reseda, CA 91335
1-800-821-5122 FAX (818) 708-8470
E-Mail: eclipse@rainbowsymphony.com
www.rainbowsymphony.com/soleclipse.html

Solar Eclipse Cruises

English Channel
or
Mediterranean
August 1999

7 to 14 day cruise and cruise-tour options.

CRUISE HOLIDAYS®
Cruise Holidays - Littleton, Colorado
1 800 533-4588
Independently Owned & Operated

Take It For A Spin!

MAG 1 Portaball
8" f/6 or 12.5" f/5
Rotatable Tube
Exceptional Optics

Easy, Quick Set-up

MAG 1 INSTRUMENTS
16342 Coachlight Dr.
New Berlin, WI 53151
414-785-0926

SEE It Spin Online!
mag1instruments.com

METEORITES
Michael I. Casper, Meteorites, Inc.
Post Office Drawer J
Ithaca, New York 14851 U.S.A.
Phone: 607-257-5349 Fax 607-266-7904
e-mail: casper@meteorites.com
http://www.meteorites.com

Eclipse Millennium

Turkey or Austria

You missed the first total solar eclipse of this millennium (Sept. 19, 1001), so don't miss the last one – Aug. 11, 1999

INNOVATIONS IN TRAVEL
OF ANNAPOLIS
800-733-3361
innovationsintravel@msn.com
www.innovationsintravel.com

NEW!! *NOVA/mount* by Virgo
Recline & Observe!! Affordable with 4 degrees of freedom!!-$299.95+s&h
Package deal - mount/tripod/bag - $399.95
Virgo Astronomics
608 Falconbridge Dr., Joppa MD 21085
Ph-410-679-7055 fax-410-679-2376
visit our site at www.Astronomy-Mall.com
See you at Northeast Astronomy Forum, 5/16

CELESTRON®
Now Carrying **MEADE**
- Telescopes, Binoculars, Eyepieces & Accessories.
- Astronomy Books & Supplies.
- Amateur & Shortwave Radio

Radio City
2663 County Road I
Mounds View, MN, 55112
612-786-4475
radiocity@skypoint.com
BUY • SELL • TRADE
800-426-2891
www.radioinc.com

NISUR systems
P3Tri-Pier & Altazimuth mounts
Features: folding eyepiece trays, extendible pier steel beanngs , & more **P3 Tri-pier $248.**
Standard Alta. $115.
Capella Alta. $185.
free brochure
info:973 678 1400 fax: 973 678 2400
www.nisursystems.com 50 Martin st. Bloomfield N.J. 07003

LX50
Dec Optimization Kits
Precision Aluminum Dec Gears
Deluxe Latitude Adjusters
Quality Replacement Knobs
Solar Filters & More!

ETX
Tripod Adapters for ETX-90/EC
MicroStar II Dual Axis Drives
Deluxe Over Size Focus Knobs
Dew Caps - Solar Filters & More!

See our website at www.scopetronix.com
No web?? We will mail / fax complete info! Visa / MC
ScopeTronix (941)573-8198

TUTHILL,
YOUR ASTRONOMICAL FRIEND SAYS:

Every Meade ETX Scope needs our:
NO DU Cap, Battery Warning Light,
Field Tripod, Solar Skreen,
Piggy Back Mount,
ETX User Video, and Finder.

For info on our custom-made Tuthill ETX accessories send SASE 9"X12" w/4 stamps to:

Roger W. Tuthill, Box 1086e, Mountainside, NJ 07092

MEGASTAR
Sky Atlas for Windows 31 95 & NT

"It's intuitive, it's easy to use and unbelievably powerful!" That's what we hear from ***MegaStar*** *owners.*

Ready to buy a computer star atlas? Or maybe the one you're now using gives more pain than pleasure. Then test drive **MegaStar**, and see just how easy it is to get to 15 million stars, 110,000 deep sky objects, 30,000 asteroids, dozens of comets and much, much more.

Download the demo today* at www.willbell.com.

*You'll need a 486 PC or better, 5 Mb hard disk space and a CD-ROM.

$129.95 postage paid in the U.S.

Willmann-Bell, Inc.
☎(800) 825-STAR
☎(804) 320-7016

P.O. Box 35025 • Richmond, Virginia 23235 • USA

STAR STUFF

PRODUCTS

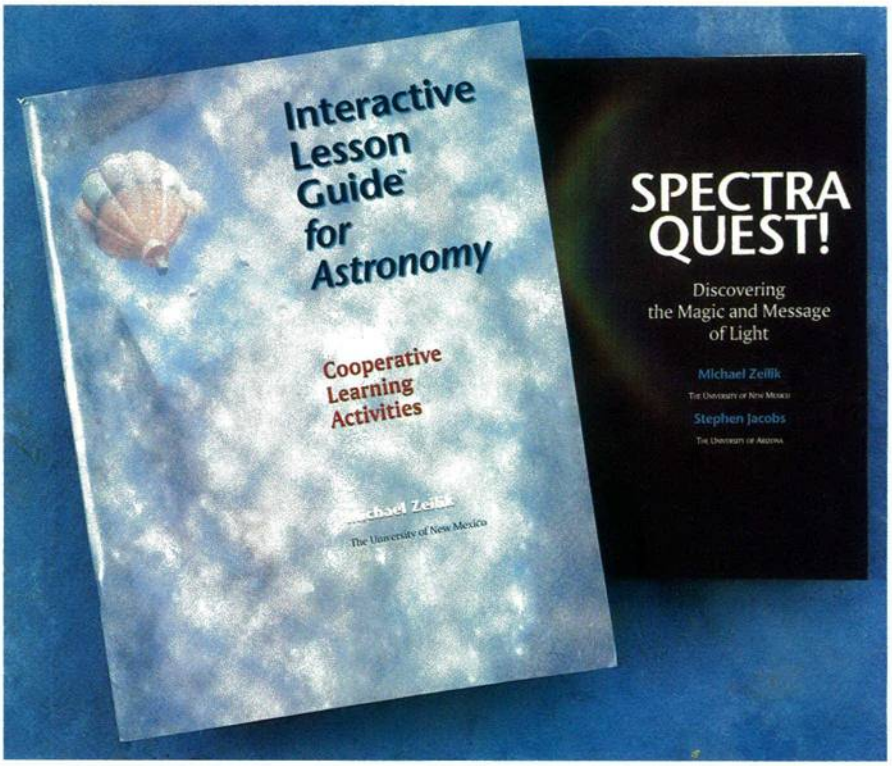
Interactive Astronomy

▶ Educators at the high school and introductory college levels have a new reference of classroom activities from author and educator Michael Zeilik. His two publications, *Interactive Lesson Guide for Astronomy* and *Spectra Quest!*, offer teachers cooperative learning activities based on Zeilik's 25 years of astronomy education experience at the University of New Mexico. The lessons, designed for novice students, provide a hands-on, minds-on guided tour of discovery.

The *Interactive Lesson Guide for Astronomy* features 32 cooperative activities that focus on important concepts in astronomy (Kepler's Third Law, Newton's gravitation, planetary motions, and others). Students have the opportunity to work at intervals in groups, adopting one of three social roles: reporter, leader, and skeptic. These are designed to help them exercise appropriate interpersonal skills. The activities take roughly 30 minutes of class time to complete, and most require no special materials except for a simple calculator.

Spectra Quest! is a conceptual guide to how diffraction gratings work. It explores the many aspects of light and includes a Night Spectra Quest grating card and background material to perform the suggested experiments.

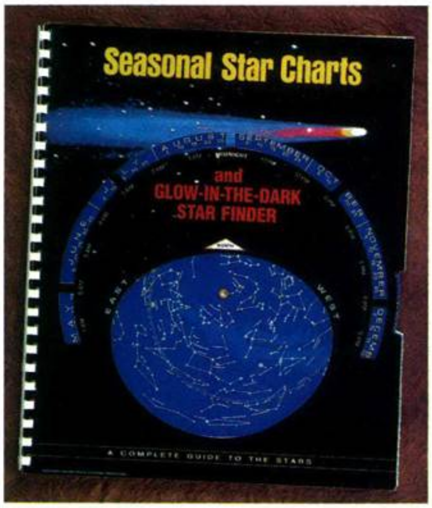
The Learning Zone, P.O. Box 23433, Santa Fe, NM 87502-3433; phone/fax, (505) 983-4183; e-mail, TLZInc@aol.com. Interactive Lesson Guide for Astronomy: $6 (discounts for volume orders). *Spectra Quest!:* $5 (minimum order of ten). *Spectra Quest!* with five grating cards: $15 (minimum order of five).

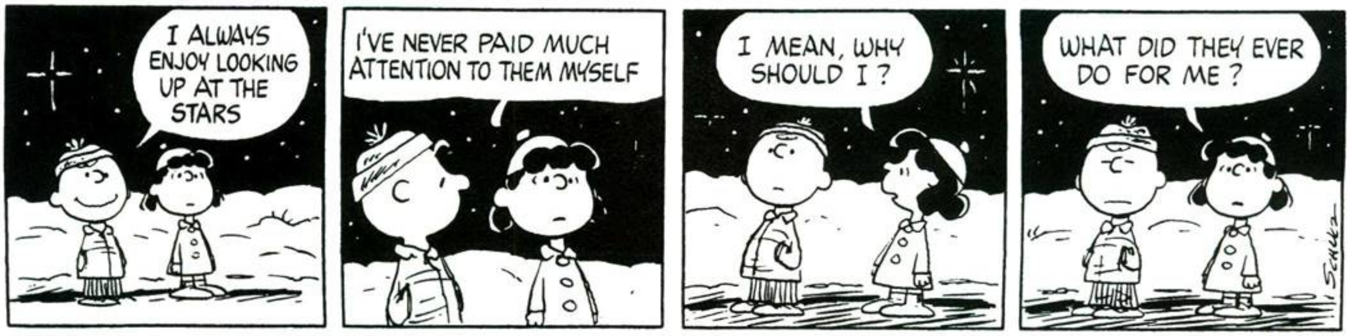

Interactive Lesson Guide for Astronomy
Cooperative Learning Activities
Michael Zeilik
The University of New Mexico
SPECTRA QUEST!
Discovering the Magic and Message of Light
Michael Zeilik
The University of New Mexico
Stephen Jacobs
The University of Arizona

Seasonal Star Hopping

▶ Hubbard Scientific has updated its popular Seasonal Star Charts. This spiral-bound skywatching guide features a glow-in-the-dark star finder wheel for 40° north latitude, while the inside contains eight star charts (two for each season) and information for locating the brightest targets with the unaided eye, binoculars, or a small telescope. The charts each measure 14 by 11.5 inches and have laminated pages.

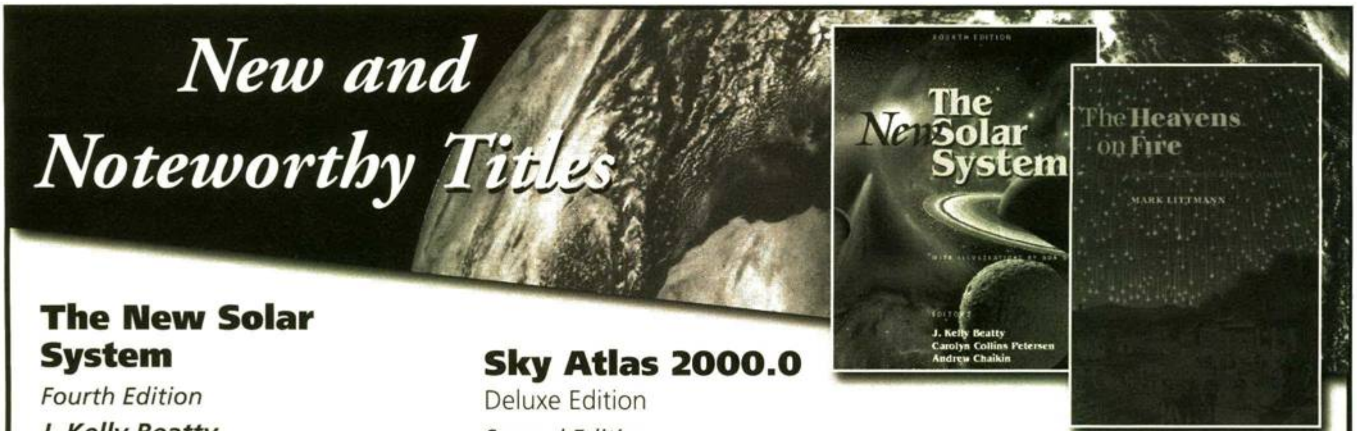
Hubbard Scientific, 1120 Halbleib Road, P.O. Box 760, Chippewa Falls, WI 54729; phone, (800) 323-8368; website, http://www.amep.com. *Seasonal Star Charts*: $18.


Seasonal Star Charts
and GLOW-IN-THE-DARK STAR FINDER
MAY
JUNE
AUGUST
SEPTEMBER
NOVEMBER
DECEMBER
EAST
WEST
A COMPLETE GUIDE TO THE STARS


I ALWAYS ENJOY LOOKING UP AT THE STARS
I'VE NEVER PAID MUCH ATTENTION TO THEM MYSELF
I MEAN, WHY SHOULD I ?
WHAT DID THEY EVER DO FOR ME ?
SCHULZ

PEANUTS reprinted by permission of United Feature Syndicate, Inc.

New and Noteworthy Titles



The New Solar System

Fourth Edition

***J. Kelly Beatty, Carolyn Collins Petersen,** and **Andrew L. Chaikin,** Editors*

"Rich with data, information, illustration, interpretation and inspiration...with special emphasis on the new discoveries from recent missions."

**– Dr. Louis A. Friedman,
Executive Director,
*The Planetary Society***

1999 421 pp.
0-521-64183-7 Hardback $59.95
0-521-64587-5 Paperback $39.95

The Molecular Origins of Life

Assembling Pieces of the Puzzle

***André Brack,** Editor*

In this volume, eighteen experts discuss everything from the environment and atmosphere of the early Earth to the appearance of organic molecules in the prebiotic environment. They also reveal various clues to the origin of life that can be obtained from other planets.

1999 428 pp.
0-521-56412-3 Hardback $85.00
0-521-56475-1 Paperback $34.95

Seven Wonders of the Cosmos

Jayant V. Narlikar

The seven wonders referred to in the title represent a range of mysterious phenomena or remarkable cosmic objects that have challenged human curiosity, including giants and dwarfs of the stellar world, the catastrophic explosion of massive stars, the illusions of space, and the majestic expansion of the Universe.

1999 334 pp.
0-521-63087-8 Hardback $59.95
0-521-63898-4 Paperback $19.95

Sky Atlas 2000.0

Deluxe Edition

Second Edition

Wil Tirion** and **Roger W. Sinnott

This long-awaited second edition offers 43,000 additional stars with all positions now derived from the Hipparcos database. The atlas opens out to reveal 26 charts, each one 20 inches wide and 15 inches deep. This large format allows the stars, nebulas and galaxies to be displayed with unrivaled clarity.

1998 c.30 pp.
0-521-62762-1 Spiral bound $49.95

Our Worlds

The Magnetism and Thrill of Planetary Exploration

***S. Alan Stern,** Editor*

In this rare, "insider" look into the universe and planetary science, readers are guided on an exciting voyage of discovery by eight distinguished researchers, from Chief Scientist on NASA's New Millennium Program Ellen Stofan to planetary theorist Bill McKinnon. Each shares to the fullest the science and emotion found in the most enticing discoveries and the wonders of the solar system.

1999 c.192 pp.
0-521-63164-5 Hardback $54.95
0-521-64440-2 Paperback $19.95

Available in bookstores or from

**CAMBRIDGE
UNIVERSITY PRESS**

**40 West 20th Street,
New York, NY 10011-4211
Call toll-free 800-872-7423
Web site: http://www.cup.org
MasterCard/VISA accepted.
Prices subject to change.**

The Heavens on Fire

The Great Leonid Meteor Storms

Mark Littmann

"...an excellent reference for anyone with an interest in the history of the Leonid meteors or who wants to try to observe the possible storms of the next few years....a must-have for meteor enthusiasts."

– Sky & Telescope

1998 360 pp.
0-521-62405-3 Hardback $39.95

The Universe Revealed

***Pam Spence,** Editor*

"This book is particularly notable for its impressive array of full-color photographs and illustrations, which, along with the text by a distinguished panel of contributors, render it a solid bet for astronomers professional and amateur."

– Publishers Weekly

1998 192 pp.
0-521-64239-6 Hardback $39.95

Life on Other Worlds

The 20th-Century Extraterrestrial Life Debate

Steven J. Dick

"Amazingly comprehensive, as well as highly entertaining...I almost wish it would put an end to the outpouring of books on the subject; nothing more need be written, until the feared/long-hoped for moment of Revelation!"

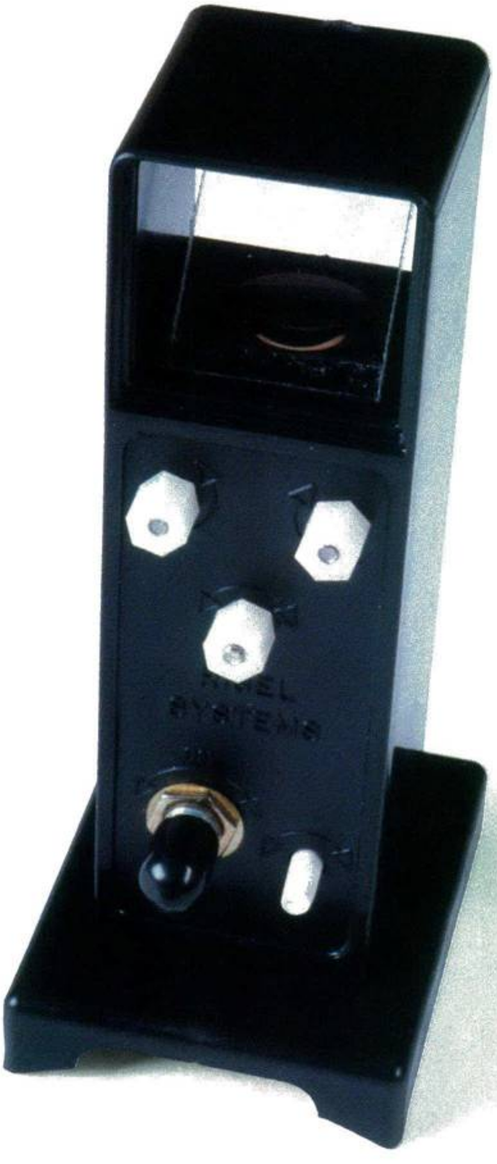
– Sir Athur C. Clarke, *CBE*

1998 304 pp.
0-521-62012-0 Hardback $24.95

QuikFinder

▶ If you're looking for an easy-to-use finder for your Newtonian reflector, Rigel Systems may have the answer. Cast in injection-molded ABS plastic, this 4.5-inch-tall upright finder clips easily on its 2 by 2.5-inch base. The finder projects red crosshairs and two dotted circles at intervals of 1° and 2° of sky and can be placed in either pulse or continuous illumination mode. An ultraefficient LED and lithium battery are included.

Rigel Systems, 26850 Basswood Avenue, Rancho Palos Verdes, CA 90275; phone/fax, (310) 375-4149; website, http://pw2.netcom. com/~rigelsys/Rigelsys.html. QuikFinder: $39.95.



BOOKS

Worlds Without End: The Exploration of Planets Known and Unknown

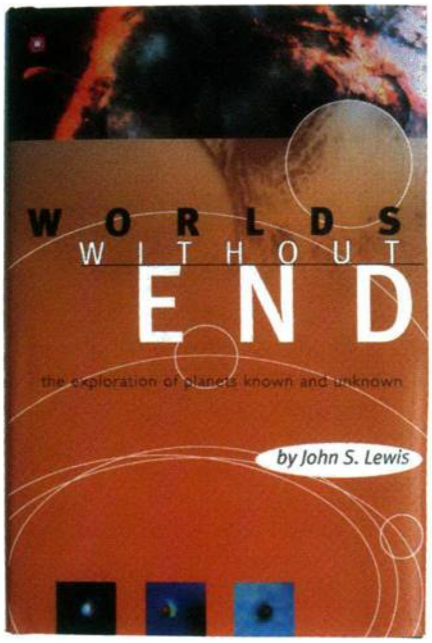
John S. Lewis, 236 pages, Perseus Books, Reading, Massachusetts, 1998, ISBN 0-7382-0011-5; hardcover, $24.

▶ Only scant centuries ago, people who openly professed their belief that our world orbited another celestial body risked religious excommunication or, worse yet, death. University of Arizona planetary scientist John S. Lewis shows just how far we have come. In *Worlds Without End,* he explores the probable millions of other solar systems in the universe. Describing this realization as, "perhaps the most exciting legacy of scientific research in this decade," Lewis engages readers of all levels in an account of what distant worlds might be like.

The book begins with an impressive synopsis of the historical debate over the existence of other worlds and possibilities of interstellar travel. Readers learn about early Greek philosophers who studied the heavens as long ago as the sixth century B.C. and of others who imagined traveling to other worlds as early as the first century A.D.

From here, Lewis provides a comprehensive tour of the solar system to exemplify the wide variety of potential planets. Planetary materials exist in four basic forms: rock, ice, liquid, and gas. But there's more to planet-forming than just composition. The ensuing chapters describe the gamut of chemistry and physics that determine a star's likelihood of forming various planets. A planet's size, orbit, and the distance it lies from its star are just a few of the variables Lewis covers, not to mention various planets' potential for harboring life.

Addressing life on other worlds, Lewis suggests that biology may not be limited to earthlike planets. "Planets, to be congenial to life, really should have lots of liquid water, and they really should not be too hot, too short-lived, or too unstable in their environmental conditions," he writes.



Lewis mostly employs jargon-free language. An occasional "Ganymedian" or "parsec" slips in without definition. However, these words will hardly bewilder lay readers. Lewis possesses an obvious aptitude for simplifying scientific concepts. In one chapter, for example, he describes making a "batch of Earth-stuff" into three different-sized planets. The results effectively make the point that slight variations in physical parameters can have major effects on planetary evolution. "Under-the-bed-dust-bunny" analogies of planetary accretion and one-liners — "as with humans, [planetary] maturation usually has a leveling effect on eccentricity" — emulate the subtle humor and metaphorical language employed by Carl Sagan, to whom Lewis in part dedicates his book.

Surprisingly, Lewis covers only briefly recent research on the existence of extrasolar planets. After 200 pages on planetary physics and chemistry, the author cursorily introduces the ideas of interplanetary travel and planet terraforming — both complex notions that deserve far more space in a book about other worlds.

Such a minor weakness hardly discredits the extraordinary picture Lewis paints of a universe teeming with countless types of solar systems. Well-written and solidly grounded, *Worlds* allows readers to appreciate the value of a life-bearing planet like Earth.

— *Amy Paige Snyder*

2" Konig MK-70—25 and 40mm, 70 degrees!

Are these the best value in the world for those seeking extremely wide angle eyepieces? Quite possibly. Our 38 years of product leadership in eyepiece design is exemplified in these remarkable oculars. Unique design allows filter to be placed on either end. Fully multi-coated. Stunning wide-field views! Best of all, exquisite Japanese craftsmanship. . . . . **25mm–$179.95, 40mm–$199.95**

König—still the best by any test!

The "grandfather" of all wide-angle oculars, the unique König design is constantly imitated, but never equaled. But wide field alone shouldn't be the whole story. Our superior full multi-coatings and optical glass consistently reveal fainter stars than most competitive brands regardless of price. 1-1/4" . . . . **12mm, 60°–$79.95, 16mm, 65°–$79.95, 24mm, 60° –$99.95, 32mm, 52°–$114.95**

Super-Erfles–an exciting new design!

The first major change in Erfle lens formation in many years yields a wide field with better edge definition.Great news for fast Newtonian owners! Five elements, multi-coatings, and better optical glass yields the ultimate in Super Erfle design. . . . . . **16mm or 20mm, 65 degree–$79.95, 25mm, 60 degree–$89.95**

Classic Orthoscopic—still the ultimate in high resolution imaging

Yes after all these years we are still selling loads of these classic Abbe Orthoscopic oculars. After trying other designs, experienced observers always return to these when they want maximum resolution. We guarantee these will put many expensive multi-element oculars to shame when focused on planetary details. **Available in 4, 5, 7, 12, 18, & 25mm. Call us for pricing.**

New Online Catalog

www.universityoptics.com

University Optics—for 38 years your source of exceptional quality telescope components

32mm König 2"–exceptional deep-space views. For those seeking one of the world's truly fine wide angle oculars, the 32mm König in 2" format offers a superb 60 degree field. The 32mm offers the ideal "visual equalization" for viewing nebulae and galaxies. Superior Japanese craftsmanship with full multi-coating **$129.95**

2" Mirror and Prism Diagonals

We offer extremely fine quality full-aperture 2" diagonals in both traditional mirror and multi-coated glass prism. Combine these with our 55mm Plössl for a wide true field of view. . . . .
Prism type — $210, Mirror Type — $105.00

The Klee. Not just another Barlow!

The 2.8X Klee has earned a reputation over the years among experienced observers as the ultimate in image amplifiers. Its unique all air-spaced 3-element design yields the lightest, most compact Barlow on the market. Many report coma correcting properties when used with Newtonians. Multi-coated **$79.95**

Postage and Handling

Merchandise Total with Shipping Charge

Up to $69.99	$4.95
$70.00 to $99.99.	$5.95
$100.00 to $199.99 . .	$6.95
$200.00 to $299.99. . .	$7.95
$300.00 and up.	$8.95

Please Note—
Our postage and handling are based on the total value of the order, not per individual item. Just one more way we save you money!

HOW TO ORDER

Free CATALOGUE—If you would like our brochure, we will send it free via 3rd class mail. If you wish it sent via first class, please send $1.00. **Catalogues outside the U.S.A. are $3.00.**

Mail Order—Simply write us a letter with your requirements. Payment via VISA, MASTERCARD, personal check, or money order.

Guarantee—It has been our policy for the last 38 years to always offer a money-back guarantee on all our items.

All prices and specifications in this ad are subject to change without notice. Our phones: 734- 665-3575, 800-521-2828, FAX 734-665-1815 Hours are 9:30 a.m. to 5 p.m. EST, Mon.- Fri., 10 a.m. to 3 p.m. on Sat.

TOLL FREE ORDER LINE — 800-521-2828
Catalog Requests, Questions — (734) 665-3575
University Optics
P.O. Box 1205 Ann Arbor, MI 48106

BinocView—use both eyes!

Experienced viewers know using both eyes is better. Unit features preferred 45° angle. Multicoated optics. Diopter adjusts on right side. Screws directly to Schmidt-Cass. Weighs only 1.5 lb. Save hundreds of dollars. **$595.00**

CCD Cookbook Camera parts—build your own high performance camera!

University Optics is offering a fully machines and superbly finished camera head aluminum parts set for ***The CCD Camera Cookbook***. Screwdriver assembly saves you hours and hours. Makes building the camera a real joy. Please specify if building the 211 or 245 chip model . . . .
Metal parts set $89.95

Electrical parts for CCD Camera. We carry the TC211 and TC245 chips as well as most of the electrical components needed to assemble the camera kit. Please call or write for current prices.

The CCD Camera Cookbook by Berry, Kanto, and Munger. This is the book that started the "do-it-yourself" CCD revolution! The Internet is full of breathtaking images. Build a CCD Camera that connects directly to your computer. Complete and detailed step-by-step instructions. Includes IBM software to make it all happen. . . . .**Only $29.95**

Wide Angle 12mm Plössl. The world's most unique Plössl features an incredible 60 degree field! Multi-coated optics set in stunning black and gold metalwork. The best news of all is that it's made right here in our Michigan facility. A distinctive addition to your high performance eyepiece collection **$69.95**

Our 8x50 Finders help you locate objects quickly and accurately!

Our 8x50 finder comes with a 1-1/4" prism wide-field crosshair eyepiece. All aluminum construction. Fully coated. U.S.A. **$125.00**

8x50 Erect Image Model. We also offer our 8x50 with a right-angle Amici prism for correctly oriented fields of view. Once you try it, you'll never go back **$179.95**

At Roger W. Tuthill, Inc.,
We Don't Just RESHIP Meade and Celestron Scopes as Others Do,
We Test Them Individually.

Our Experience of 25 Years Lets Us Apply a "Personal Touch", Inspecting & Improving the Telescopes We Sell. Our Line of Accessories Makes Them Easier to Use and Gives You Less Hassle. Why Gamble With a Big Volume, Impersonal, Quick-Sale-Mail-Order Company? For Answers or Advice, Call TOLL FREE 1-800-223-1063 and Talk to **Astronomers, NOT Clerks.**

CHECK OUT OUR NEW WEB SITE: WWW.TUTHILLSCOPES.COM

All DELUXE CERTIFIED MEADE and CELESTRON S.C.T.s come with:

- **Tuthill Inspection, Guarantee and After-Purchase Support**
- **Free set of Tuthill Astro-video Instruction tapes.**
- **25% off Tuthill accessories when purchased with scope.**

Visit our showroom. We carry binoculars, Lumicon filters, JMI products, Tele Vue refractors, astronomy books, software, and ALL brands of accessories.

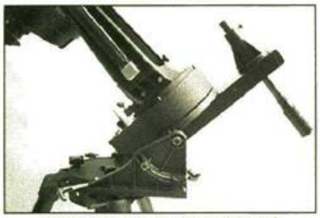
We clean and repair Meade & Celestron SCT's.

Tuthill Accessories

Meade 8" LX50 or Celestron Ultima 9¼" on Isostatic Equatorial Mount

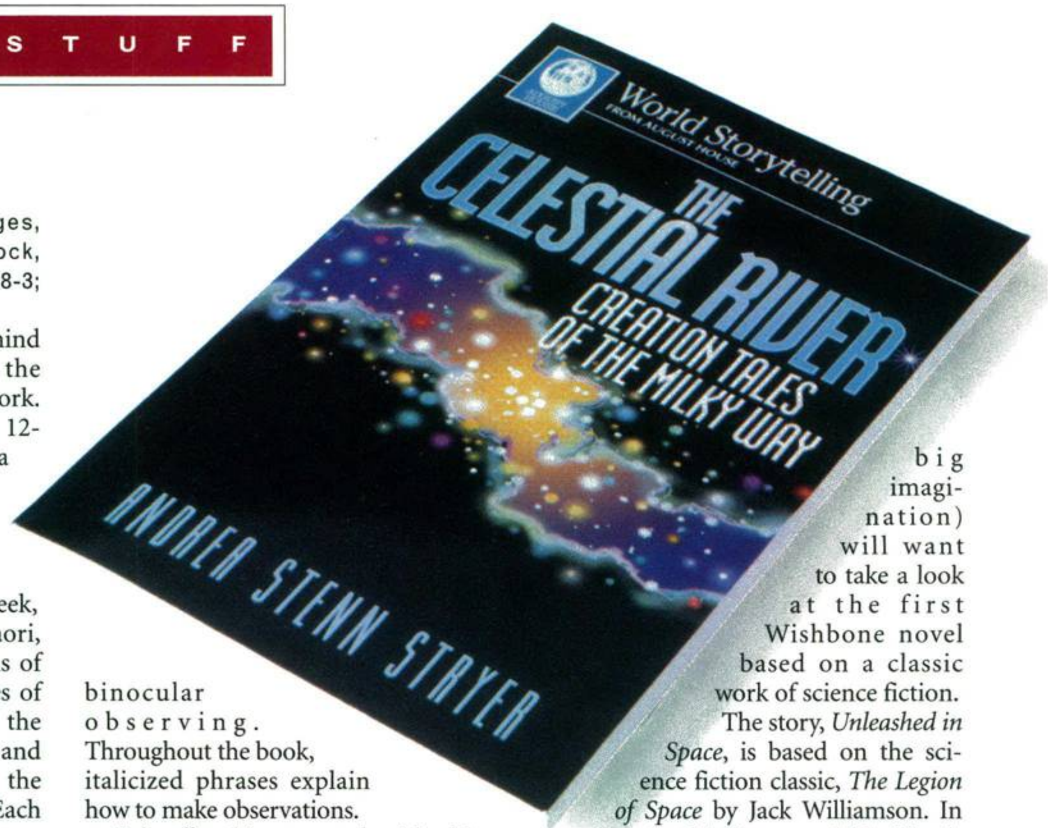
Heatable NO DU CAPS for SCTs and Refractors

80mm Erect Image ULTIMATE FINDER includes bracket and 21mm ocular.



PRECISION POLAR AXIS FINDER® for EXACT polar alignment in minutes.

Roger W. Tuthill, Inc.
11 Tanglewood Lane, Dept. A • Mountainside, NJ 07092 • Phone 908-232-1786 • FAX 908-232-3804
VISA, MC, COD, Personal Checks, Time Payment Plans



The Celestial River

Andrea Stenn Stryer, 80 pages, August House Books, Little Rock, Arkansas, 1998, ISBN 0-87483-528-3; softcover, $7.95.

▶ The mythology and folklore behind the faint band of light we call the Milky Way is highlighted in this work. Though written for a 9- through 12-year-old audience, the book is a delightful read for adults as well.

The Celestial River is based on seven stories — each a different legend from one of seven cultures that include Japanese, Greek, Navajo, Australian Aborigine, Maori, Kalahari San, and the Toba Indians of Argentina. These myths weave tales of love, avarice, and creation: from the Japanese love story of Hikoboshi and Tanabata, to the stellar dance of the Australian Aborigine, Preipriggie. Each chapter opens with a beautiful illustration by Wendy E. Hall, who used black-and-white line drawings to depict scenes from the given stories.

40 Nights to Knowing the Sky: A Night-By-Night Skywatching Primer

Fred Schaaf, 252 pages, Henry Holt and Co, New York, 1998, ISBN 0-8050-4668-2; softcover, $17.95.

▶ This book provides beginning astronomers with good starting points for observations and introduces them to cosmological concepts in a naturally progressive manner.

The first three chapters familiarize the reader with terms needed for observing, such as horizon, zenith, azimuth, meridian, and altitude, to name a few. During the first two weeks of observing, readers will learn how to identify planets, recognize moon phases, and understand concepts such as artificial satellite motions and the equatorial system of celestial positions.

The remainder of the book, beginning with day 15, is then divided into three main sections. "Nights of the Heavens in Motion"orients readers to the motions of planets, moons, and stars. "Nights of the Heavens in Variety" introduces naked-eye sights and phenomena such as eclipses and occultations. "Nights of the Heavens in Depth" deals with telescope and binocular observing. Throughout the book, italicized phrases explain how to make observations.

Schaaf's ultimate goal with this helpful and well-organized approach is to "inspire you to step outside to meet the sights of the night sky ... and to learn about the workings of the greater universe."

Wishbone: Unleashed in Space

Alexander Steele, 256 pages, Big Red Chair Books, Richardson, Texas, 1999, ISBN 1-57064-329-6; softcover, $3.99.

▶ Fans of the popular public television series *Wishbone* (the little dog with a big imagination) will want to take a look at the first Wishbone novel based on a classic work of science fiction.

The SUPER Adventures of Wishbone
#3
UNLEASHED IN SPACE
By Alexander Steele
Inspired by The Legion of Space by Jack Williamson

The story, *Unleashed in Space*, is based on the science fiction classic, *The Legion of Space* by Jack Williamson. In the tale, Wishbone and his friends Joe Talbot, Samantha Kepler, and David Barnes take off for Space Camp and a once-in-a-lifetime, out-of-this-world adventure. During their mission as astronaut trainees, Wishbone imagines himself as the great space hero John Ulnar who lives more than a thousand years in the future. To save Earth from alien invaders, Ulnar travels to a strange, distant planet where he faces bizarre creatures that try to thwart his rescue of a beautiful young woman who is mankind's only hope for survival.

The release of *Unleashed in Space* includes a national sweepstakes that features three Grand Prize trips to Space Camp in Huntsville, Alabama. Young readers wishing to enter must be between the ages of 9 and 12 and in fourth, fifth, or sixth grades at the start of the fall 1999 school year. Entry forms and information will be available at participating retailers in May and June, on the Wishbone website at http://www.wwwishbone.com, or by calling the Wishbone fan club at 800-888-9474. All written entries must be received by June 19, 1999. The three Grand Prize trips include airfare, meals, lodging, and camp fees for one person. The sweepstakes is open to all residents of the United States and Canada (excluding Quebec) who meet the above criteria, as well as the rules contained on the entry form.

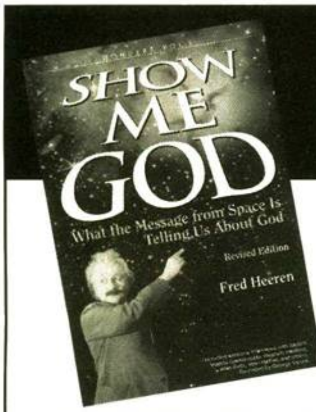
CCD IMAGING EQUIPMENT™

Flip Mirror - Find & Focus *Fast*

- **CCD Cameras**
- **Filter Wheels motor or manual**
- **ALL CCD Filters**
- **Flip Mirrors**
- **Beam Splitters**
- **1.25, 2-in. & T-mounts**

Equipment for **ALL** CCD's **AND** visual use.

MURNAGHAN™ Instruments
1781 Primrose Ln., W. Palm Beach, FL 33414
Phone: 561-795-2201 • FAX: 561-795-9889
WWW Catalogs: http://www.murni.com
E-Mail: murni@bix.com



Evidence for God?

THE BOOK
(NEW, REVISED EDITION):

Show Me God brings together today's top space scientists to talk about how their discoveries affect questions about ultimate origins, the likelihood of extraterrestrials, why we're here, and the nature of God.

- **Stephen Hawking** explains how God relates to his proposal from *A Brief History of Time*.
- **George Smoot** tells why he calls his NASA COBE satellite discovery "fingerprints from the Maker."
- **Alan Guth** describes the universe's "fine-tuning."
- Nobel prize-winners talk about the implications of their discovery of a "creation out of nothing."

With 100 new pages on the search for extraterrestrial life and the latest findings about the early universe, this best-selling book just got better.

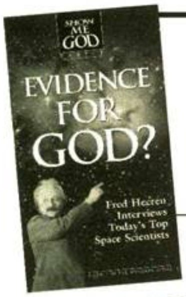
This cutting-edge book explores creation where science and religion ask the same questions and think the same thoughts.

—George Smoot, head of NASA satellite team

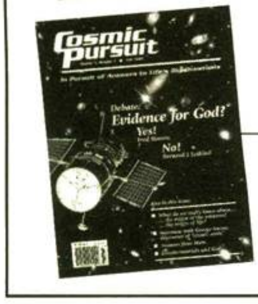
Brings the latest space results down to Earth—a story well told.

—John Mather, COBE satellite chief scientist

Hardcover. Regular: ~~$22.99~~. Introductory price: $19.99.
393 pages. 98 photos.



NEW VIDEO: ***Evidence for God?***
—Fred Heeren Interviews Today's Top Space Scientists
Hear leading astronomers discuss how their discoveries affect life's big questions.
VHS. 30 minutes.
Regular: ~~$19.99~~. Intro. price: $16.88.



NEW MAGAZINE: ***Cosmic Pursuit***
For those who want to keep up with the latest on science/faith issues, this quarterly explores cosmic and biological origins, the search for extraterrestrial life, and the source of consciousness and nature's fine-tuning.
U.S. annual subscription price: ~~$24.95~~.
Intro. price: $19.99 (no extra shipping charges)

Available at bookstores, or call today:
1-800-743-7700 Visa/MasterCard/Discover
Day Star Publications, 326 S. Wille Avenue, Wheeling, IL 60090
Make checks out to "Day Star" and add $1.94 for shipping.
See our informative web site at: www.daystarcom.org

PRECISION SOLAR FILTERS

Recognized around the world for product quality and cutting edge advances, our filters are the preferred choice of telescope retailers and used exclusively by NASA aboard the Space Shuttle. Other professional users include: ABC, BBC,CBS, NBC, CNN, NOVA, The Discovery Channel, National Geographic and most major universities and observatories. Tens of thousands are in use world wide.

TYPE 2+ - Made with high quality hand select glass and coated with our exclusive Solar II Plus. The most durable filter on the market. Transmission is 1/1,000th of 1%. (OD-5). Great for both visual and photographic use. Solar Image is yellow-orange. Guaranteed 15 yrs.

TYPE 3+ - Lighter density, 1/100th of 1% (OD-4) for maintaining fast shutter speeds when using 'slow' fine grain films. For photographic use only. Solar image is yellow-orange. Guaranteed 15 yrs.

POLYMER PLUS - Exclusive *Thousand Oaks Optical* polymer filters offer high resolution at an economical price. Unlike aluminized Mylar, solar image is yellow with better resolution and contrast. Coated on two sides with our exclusive Solar II Plus. Image quality and resolution equals our glass. Guaranteed 10 years.

	TYPE 2+ or 3+		**POLYMER PLUS**	
APERTURE	Full Aper.	Off-Axis	Full Aper.	Off-Axis
2.4" to 3.1"	$ 69.00	N/A	$ 49.00	N/A
3.5" to 4"	79.00	N/A	59.00	N/A
4.25" to 5"	99.00	N/A	69.00	N/A
6"	109.00	$ 79.00	$ 79.00	$ 69.00
7" to 8"	129.00	89.00	89.00	79.00
10"	149.00	109.00	N/A	89.00
11"	159.00	119.00	N/A	99.00
12" to 13.1"	179.00	139.00	N/A	119.00
14"	199.00	149.00	N/A	139.00
40-80mm Binoc	129.00 pr	N/A	89.00 pr	N/A

NEBULAR FILTERS - Enhance your deep sky viewing with the latest in multilayer coating technology. Our filters transmit desired wavelengths in a very steep slope vs. gentle transition slopes in competitive brands. This means better contrast and overall performance. Made in the U.S. 1.25" - $89 Ea., 2" - $179 Ea.

LP-1 (Broadband) For slight to moderately light-polluted areas.
LP-2 (Narrowband) For heavily light-polluted areas.
LP-3 (Oxygen III) For diffuse and planetary nebulae.
LP-4 (H-Beta) For Horsehead, Calif, & other faint nebulae.

SOLAR ECLIPSE VIEWERS & FILMS - We manufacture a complete line of eclipse viewing devices and thin films including Mylar & our exclusive 'Black Polymer.'

Payment may be made by personal check, bank check or money order. We also accept Visa, MC & AMX. Free brochure available or visit our web site.

THOUSAND OAKS OPTICAL
BOX 4813-A, THOUSAND OAKS, CA. 91359
TOLL FREE ORDER LINE: 800-996-9111
INFORMATION LINE: 805-491-3642
Phone Hours: 10:00 - 5:00 Pacific - Mon-Fri
FAX: 805-491-2393 (24 hours)
www.thousandoaksoptical.com

BYTES

Touring the Universe Through Binoculars Star Atlas

As a companion to his popular book of the same name, Phil Harrington, with G. Dean Williams, now offers an interactive CD-ROM star atlas.

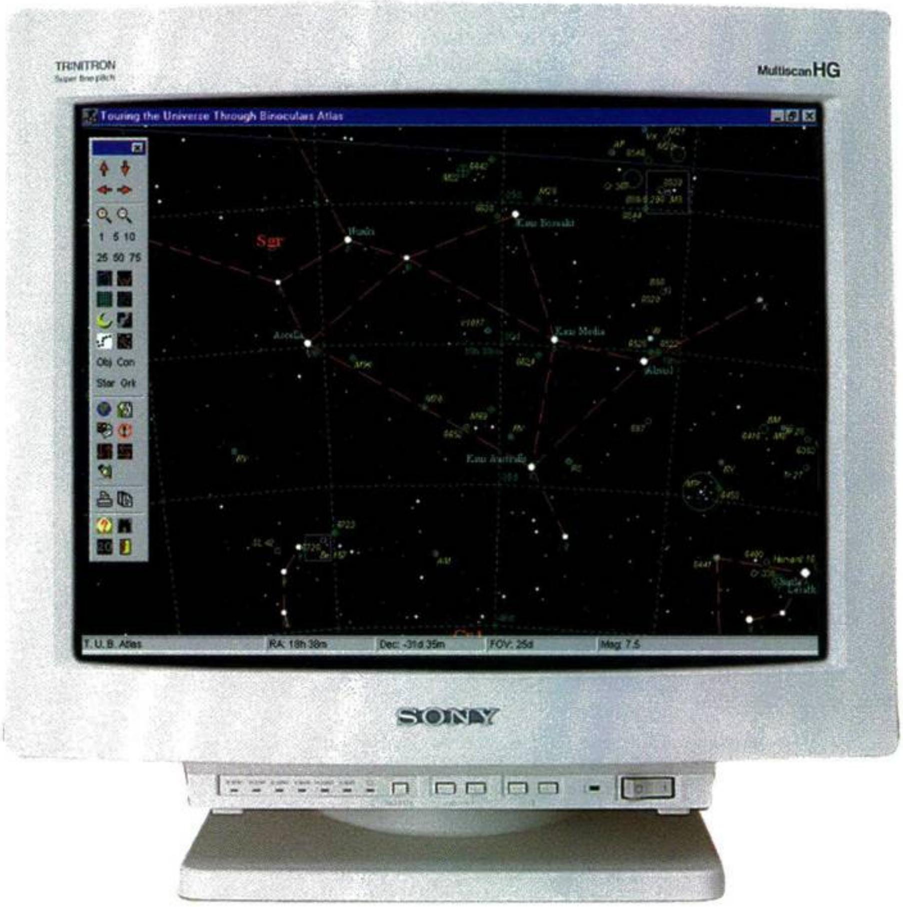
Touring the Universe Through Binoculars Star Atlas plots the more than 1,100 objects listed in the book, many of which are not listed in other popular atlases.

The program shows stars to 9th magnitude, a reasonable limit for binoculars, and offers users the option to show fewer stars. Other options include black-and-white or color printing capabilities; the ability to zoom in or out to recreate the field of view through your binoculars; locations of the sun, moon, and planets; a buyer's guide to binoculars; and a pop-up menu that provides specifications on objects highlighted in the book. These specs include celestial coordinates, magnitude, apparent size, and others.

As a bonus to the CD-ROM, you'll receive a guide to binoculars, offering tips on how to select the right ones.

Minimum system requirements are as follows: an IBM-compatible computer using Windows 95/98/NT, a Pentium-90 with 16 MB of RAM, and 5.25 MB of free hard-disk space. No MAC version is yet available.

Touring the Universe Through Binoculars Star Atlas CD-ROM is only available to individual buyers through the Internet at http://ourworld.compuserve.com/homepages/pharrington/tuba.htm. Price: $19.95 plus shipping and handling.



PRODUCT INFO

Astronomy assumes no responsibility for the product information supplied by manufacturers. Prices are retail and subject to change without notice. Suppliers should send announcements and color photographs to Star Stuff, P.O. Box 1612, Waukesha, WI 53187, or e-mail starstuff@astronomy.com. Check *Astronomy*'s website for further product information — http://www.astronomy.com

The Webweaver Picks

The Galaxy Catalog

A collection of digital images of 113 nearby galaxies. Each image was taken in several passbands. A color composite image is included for each galaxy.

http://www.astro.princeton.edu/~frei/galaxy_catalog.html

Color Photographs from the Anglo-Australian Observatory

Photos taken with the 3.9-meter Anglo-Australian Telescope.

http://newt.phys.unsw.edu.au/~mgb/astroimages.html

IPAC – Harold Corwin's Web Page

Selected astronomical catalogues and online data services. Includes several extragalactic catalogues, databases, and links.

http://spider.ipac.caltech.edu/staff/hgcjr/

Very Large Telescope Images – Galaxies

Astronomical images from the VLT displayed as clickable icons. Photos also include brief information about the images.

http://http.hq.eso.org/outreach/info-events/ut1fl/astroim-galaxy.html

NASA/IPAC Extragalactic Database (NED)

Looking for a particular object? NED can help you pinpoint its location.

http://nedwww.ipac.caltech.edu/

Hubble Space Telescope

HST images of nearby and distant galaxies as well as nebulae, star clusters, and more.

http://oposite.stsci.edu/pubinfo/Subject.html

PRICES TOO LOW TO PRINT!

"Any other legitimate listed prices will be bested!"

MEADE

DOBSONIANS
REFRACTORS
REFLECTORS
SCHMIDT-MAKS
8" F6.3 COMPUTER $1995

SPECIALS

Dealers Invited

CELESTRON

CM 1100 $AVE
CG 91/4" $2149
LOSMANDY EQ SPECIALS
EXPORT SPECIALIST

6" NEW 8"

ALL METAL DOBS

$319 $419

4 1/2" 400 mm
$249

BAUSCH & LOMB

+ All major brands

WWW. ASTROPTX.COM

• PUBLIC WELCOMED • NO SALES TAX COLLECTED
• SHOWROOM: 57 NORTH STREET/ SUITE 401, DANBURY, CT 06810
• PHONE ORDERS 9AM-MIDNIGHT (7) DAYS A WEEK
E-Mail: astroptx@astroptx.com JCB
SEE FULL PAGE AD IN JULY ISSUE PAGE # 103

WHOLESALE OPTICS DIVISION
59 MINE HILL ROAD, NEW MILFORD, CT 06776
TEL: (860) 355-3132 CATALOG (2lbs.) $10 (REFUNDABLE)

LOWEST PRICE GUARANTEE*

1999 ECLIPSE - TURKEY

Eclipse Edge Expeditions

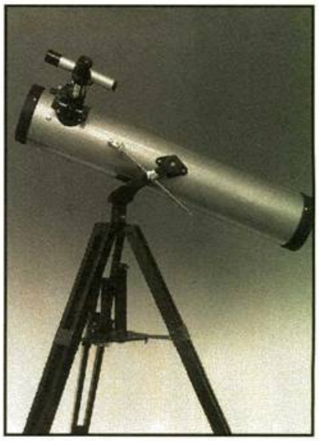
A total solar eclipse is nature's most awesome spectacle. Led by astronomers, Aug. 7-13, from $2150 pp. Better chance of clear skies than Europe. Extensions to Troy/Ankura/Turkish Riviera & Europe. Send for brochure + registr. forms or see <www.metaresearch.org/edge>

Eclipse Edge Expeditions
P.O. Box 15186
Chevy Chase, MD 20825
Recorded Announcement:
800/898-3343

YOWA TELESCOPES

4.5" (1000)

4.5" (900)



3"

60mm

Manufacturer: **YOWA Sports Optics Co., Ltd.**
Agency: **Apollo-Foco International, Inc.**
2806 1/2 Bookcliff Ave.
Grand Junction, CO 81506
Tel: (970) 255-9233 Fax: (970) 256-7940
http://www.apollo-foco.com
E-MAIL: scott@apollo-foco.com

APOLLO FOCO

Astronomy
Magazine

StarParty '99

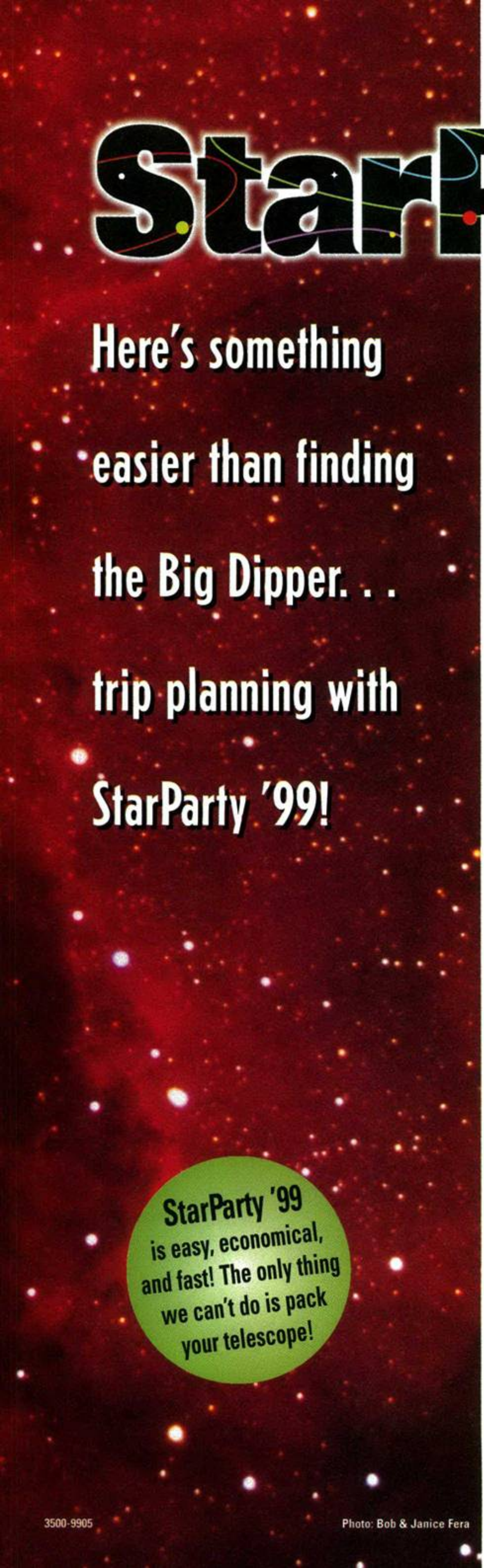

Here's something easier than finding the Big Dipper. . . trip planning with StarParty '99!
StarParty '99 is easy, economical, and fast! The only thing we can't do is pack your telescope!
3500-9905

Photo: Bob & Janice Fera

StarParty '99 leaves the hassles of travel planning—endless phone calls to airlines, searching the Web for hotels, haggling prices for car rentals—to the experts. Now, you're only one step away from enjoying the night skies at an *Astronomy* Magazine cosponsored event.

Simply register at the star party of your choice, then call Specialty Tours at 1-800-677-9412 to set up your entire travel itinerary.

Mason Dixon Star Party • June 11–13
Spring Valley County Park, near York, Pennsylvania
Register with Jeri Jones at 717-840-7226 or e-mail jlj276@aol.com
Web site: http://home1.gte.net/dmdewey/mdsp.htm

Astronomical Society of the Pacific • July 1–7
(Includes Universe '99 - July 2–4) Toronto, Ontario, Canada
Register with Lori Keechler at (415) 337-1100 or e-mail lkeechler@aspsky.org
Web site: www.aspsky.org
Features a beginner workshop.

Nebraska Star Party • August 7–14
Merritt Reservoir, near Valentine, Nebraska
Register with Tom Miller at (402) 466-4170 or e-mail tmiller232@aol.com
Web site: http://www.4w.com/nsp/
Features a beginner workshop.

Oregon Star Party • September 9–12
Indian Trail Spring in Ochoco National Forest, near Portland, Oregon
Register with Susie McClain at (503) 667-9267 or Chuck & Judy Dehtloff at (503) 357-3163,
or e-mail ospinc@teleport.com

Okie-Tex Star Party • October 4–10
Near the Panhandle of Oklahoma
Register by e-mail seadkins@icon.net
Web site: http://www.icon.net/~seadkins/okie-tex.html

Deep South Regional Stargaze • October 6–10
Percy Quin State Park, near McComb, Mississippi
Register with Barry Simon at (504) 283-7592 or e-mail bsimon615@aol.com

Mid-Atlantic Star Party • October 7–12
Boy Scout Camporee Camp Reeves, South of Robbins, North Carolina
Register with MASP at (919) 362-5194 or e-mail john@bsa/net
Web site: http://www.bsa.net/masp/

Enchanted Skies Star Party • October 7-10
Socorro, New Mexico
Register with the Enchanted Skies Star Party at (505) 835-0424 or
e-mail chamber@socorro-nm.com
Web site: http://www.nmt.edu/~astro/essp.html

Reserve your place today!

For more information on travel packages, call Specialty Tours at
1-800-677-9412 or (727) 796-7555
Email: GS@a1specialtytours.com

ASTRO PIER
Telescope Mounting Piers

Are you tired of leveling and lining up on North? The Astro Pier virtually eliminates vibration from accidental jarring and totally eliminates the need to level and line up on North, allowing for undelayed observing and excellent astro photography. Constructed from 1/4" and 3/8" welded steel with three 3/4" leveling bolts for excellent performance.

Mounting piers for Schmidt-Cassegrain, Refractors and Newtonian.
Color: Midnight Blue, Black or White

LE SUEUR MANUFACTURING CO., INC.

3220 Lorna Road
Birmingham, Alabama 35216
Phone (205) 822-0720
Starting at $301.00 plus S/H

VISA/MASTERCARD NO C.O.D.s

WEBSITE: WWW.ASTROPIER.COM

NEW!

WirelesS
Weather Stations

Installation made easy! Davis' wireless Weather Monitor II® and Weather Wizard III® stations use our new SensorLink™ to transmit data to the display console up to 400' away! Each station comes completely pre-assembled and includes sensors, a radiation shield, a weather-tight shelter, and a display console with receiver. All without running wires!

Or try our new radio transmission solutions - Spread-Spectrum Radio Modem, UHF Radio Modem & Cellular Phone Modem. They work with all of our stations to provide data transmission from virtually anywhere.

Davis Wireless Weather Stations Feature

Inside and Outside Temperature, Wind Speed and Direction, Barometric Pressure and Trend, Wind Chill, Dew Point, Daily and Yearly Rainfall, Inside and Outside Humidity, Time and Date, Highs and Lows, Alarms.

For a FREE catalog, call AST0599

1-800-678-3669

One-year warranty • 30-day money-back guarantee

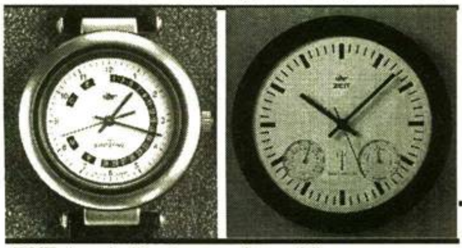
Davis Instruments 3465 Diablo Ave., Hayward, CA 94545-2778
(510) 732-9229 • FAX (510) 732-9188 • sales@davisnet.com • www.davisnet.com •

"ATOMIC CLOCK CONTROLLED"
Precision Time Pieces Synchronized to the US Atomic Clock - Accurate to 10 billionths of a Second!

SALE $69

The most accurate clock on Earth. These smart clocks tune into the radio signal emitted by the **US Atomic Clock** in Colorado- which deviates less then 1 second over a million year period. They synchronize themselves automatically to the exact same time daily and adjust even for daylight savings time and leap seconds. You can now have the world's most accurate time 24 hours a day to be in control of time or start your day. These precision ZEIT timepieces are **engineered in Germany** and are **easy to use** using the latest in radio-controlled technology. Just set the time zone and the built in micro chip does the rest. **ZEIT- accurate! precise! reliable! & fully automatic**

ZEIT Atomic Wall Clock with regular or roman numbers For home or office—1AA, Large 12". **$79** ($99 in wood)



ZEIT Atomic Watches are the **world's most accurate watches** with hour, minute and seconds. Hands spin at 80 times its normal rate until they stop at the precise time. Shock-resistant polymer case with built-in receiver for Atomic Time Signal (water-resistant). Mineral lens, **black** or **white** dial &leather band. **Only $149** ($249 in Ceramic)
NEW - Digital Atomic Sportswatch with UTC etc. $99

ZEIT Atomic Dual Alarm & ZEIT Atomic PC Sleek European design with large 2 line LCD display with exact time in hours minutes, seconds; month and date, or any two US and world times. At 8oz ideal for travel; incl. dual alarm with night-ime illumination, time zones and lithium battery backup. Super sensitive built-in receiver. 2AA. incl. **Black** or **Silver** arch design at 5"x4"x2 1/2" **Sale! $69.** Buy any two Clocks **get 20% off** 2nd. **ZEIT PC** with serial cable and software for WIN. Also shows **UTC Time in 24hrs** mode. **Sale! $99**

Call for full line of atomic clocks & watches
Atomic Clock Controlled Time:
Credit Card Orders
Call toll free **1-800-985-8463** 24hrs
send checks/money orders to:
Arcron Zeit, Inc. 1010 Jorie,Oak Brook, IL 60523
fax. 630.575.0220 **http://www.arctime.com**

KENDRICK
Dew Remover
SYSTEM

A truly effective solution for the prevention of dew and frost on all optics and accessories.

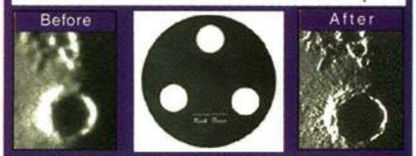
		Felt lined flexible Dewcaps	
controller	$70.00	ETX	$25.00
.965"	$33.00	C5	$32.00
1.25"	$35.00	6"	$42.00
2"	$38.00	7"/C8"	$50.00
3"	$40.00	C9.25	$55.00
4"	$43.00	10"	$60.00
5"	$45.00	C11"	$70.00
6"	$48.00	12"	$85.00
7/8"	$50.00	14"	$105.00
9/10"	$60.00	**Batteries, Power supplies.**	
11"	$65.00	120v converter	$60.00
12"	$70.00	220v converter	$80.00
14/16"	$80.00	12v17AH Battery	$125.00
Telrad heater	$23.00	12v 34AH Battery	$290.00
Telescope computer control heater (Meade, Astro Physics)	$35.00	dual plug adaptor	$12.00
Laptop computer heater	$95.00	battery clip adaptor	$10.00

Our 12v 17 amp hour battery is powerful enough to drive your scope and our heaters. Comes fused, with built in cigarette lighter jack, charger, rugged, soft shell carrying case and shoulder strap. Weighs 14 lbs. **$125.00**

Rugged, flexible, felt lined dew caps for most commonly used telescopes. Sewn in velcro attachments. Lie flat for easy storage and transportation.

KWIK FOCUS LENS CAPS

A user freindly focusing aid for astrophotographers, CCDers and observers. Can be used as a collimator and lenscap.



ETX	$30.00	7" Mak	$40.00		
C5	$30.00	8" SCT	$40.00	12" SCT	$55.00
AP 105mm	$30.00	9.25" SCT	$45.00	14" SCT	$60.00
AP 130mm	$30.00	10" SCT	$45.00	16" SCT	$70.00
AP 155mm	$35.00	11" SCT	$50.00		

SOLAR FILTERS FOR KWIK FOCUS

Now available for the Kwik Focus are our off axis solar filters. Coatings are guaranteed for 15 years, Transmission is1/1000 of 1%. Color is yellow orange. The filters include an adaptor that is epoxied into one of the holes of the Kwik Focus. Solar filters can then be screwed in for solar viewing.

52mm.....$95.00 82mm.....$119.00

Hydrogen alpha filters for observing prominences and detail on the surface of the sun. From $1390.00

LASER COLLIMATORS

2"......$125.00 1.25"...115.00
Auto on / Auto off Batteries included

OBSERVING CHAIRS

Made from Baltic Birch plywood.
Fully adjustable seat. Folds flat.
Ultimate.........$125.00
Ultimate II......$160.00
(comes with attached folding accessory tray. Holds up to 5 eyepieces, charts and more.)

ASTRONOMY TENTS

"OBSERVER TENT"

A portable camping - observatory tent.
Quick set up time.
Two large rooms, one for observing and one for charts, sleeping etc.
Adjustable zip out roof.
This tent can handle scopes as big as a C14.

DIMENSIONS:
15'L X 9'W X 6'6"H
$390.00

SHELTER-DOME

A portable shelter for those seeking protection from street lights and mild winds.
-Four adjustable observing slots.
-Light and wind proof.
-Easy to set up
-Optional rain fly

DIMENSIONS:
10' L x 7'W x 6'6"H
$295.00

All Major Credit cards accepted

Buy direct or from your favourite dealer

JIM KENDRICK STUDIO
2775 Dundas St. W., Toronto, ON M6P 1Y4, Canada
P 416 762 7946 F 416 762 2765
Order line 1 800 393 5456
http://www.kendrick-studio.com
email to: kendrick@kendrick-studio.com

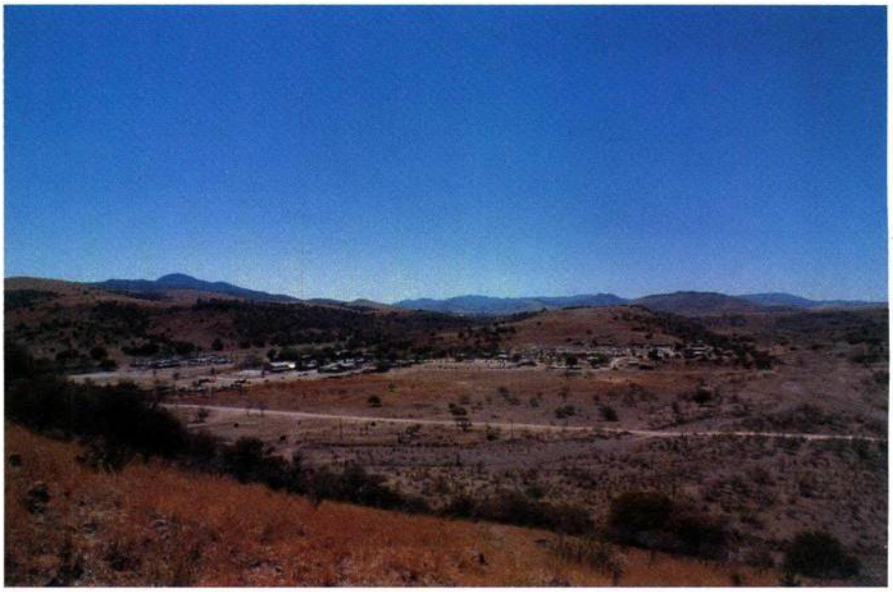
What is it that continues to draw people to the **Texas Star Party**, year after year? The location is so remote that it takes a combination of stamina and determination just to get there. It's dusty. It's hot during the day and cold at night. Yet amateur and professional astronomers, serious astrophotographers, and observers from all walks of life lug cumbersome telescopes, sensitive CCD cameras, elaborate photography equipment, even portable observatories across the country, a few overseas, for the opportunity to experience some of the darkest skies in all of North America.

Here the light from Venus shines so brightly that if you stand with it at your back, you can cast a shadow. The Milky Way, spanning the length of the sky, takes on a three-dimensional quality. The zodiacal light, a wedge-shaped glow along the ecliptic, is stunningly beautiful.

Those without a telescope should not be intimidated — the TSP offers an observing program geared toward binocular users. Even naked-eye observing is incredible from this location.

The **21st Annual Texas Star Party, May 9–16**, will be held at the Prude Ranch in the Davis Mountains of West Texas. For more information, contact the TSP Registrar, 1326 Mistywood Lane, Allen, TX 75002; e-mail, kastro@aol.com, or view the TSP website, http://www.metronet.com/~tsp/index1.html.

In cooperation with **Space Day**, taking place **May 6**, *Astronomy* magazine will include a six-page section of astronomical images in the June issue to support the Electronic Field Trip, "The Quest in the Question," and classroom activities and to inform readers of the current science behind the images. Look for it on newsstands by the end of April.


Terry Atwood

The Prude Ranch, home of the Texas Star Party, Fort Davis, Texas.

APRIL 30–MAY 1
North Central Regional Astronomical League Convention

▶ Sheraton Four Points Hotel, Cedar Rapids, Iowa. Hosted by the Cedar Amateur Astronomers. Contact Deb Bonser, 1009 Harding Street, Tama, IA 52339; (515) 484-5235; e-mail, deb.bonser@usa.net.

MAY 6
Space Day/Electronic Field Trip/Cyber Space Day

▶ National Mall, outside the Smithsonian's National Air and Space Museum, Washington, D.C. This event will feature an array of exciting exhibits showcasing the wonders of space and science. The Electronic Field Trip, "The Quest in the Question," a free live satellite broadcast reaching 4–6 million students across the country, will air at 1 P.M. EDT. Cyber Space Day is a live interactive Webcast hosted by respected journalists, featuring astronauts, astronomers, scientists, and others. For more information, call (202) 357-2700; websites, http://www.spaceday.com or http://www.challenger.org.

MAY 14–15
Sky Tour Star Party

▶ Highway 269, south of Belleview, Ohio. Contact TECH2000, 3349 SR 99 S., Monroeville, OH 44847; (419) 465-2997; e-mail, tddi@accnorwalk.com.

MAY 14–16
Southern Star Astronomical Convention and Star Party

▶ Wildacres Retreat, near Little Switzerland, North Carolina. Contact Hubert Byrd, (704) 523-8550; e-mail, geomar@trellis.net; website, http://www.335.com/caac/sstar.htm.

MAY 16
Northeast Astronomy Forum and Telescope Show

▶ Holiday Inn Conference Center, Suffern, New York. Contact Don Urban, 73 Haring Street, Closter, NJ 07624; (201) 768-6575 (eves.); e-mail, DonaldUrban@Juno.com.

MAY 22
Astronomy Day

▶ Boston Museum of Science, Boston, Massachusetts. For more information, send a SASE to Noreen Grice, Boston Museum of Science, Boston, MA 02114-1099; (617) 589-0273; e-mail, ngrice@mos.org.

MAY 22
Astronomy Day

▶ Owens Science Center, Lanham, Maryland. 6–10 P.M.; free. Contact Tom Bridgman, (301) 441-4605; John Settle, e-mail, jjscta@erols.com; website, http://lheawww.gsfc.nasa.gov/docs/outreach/gac/GAC.html.

MAY 22
Morehead Planetarium 50th Anniversary

▶ Morehead Planetarium, University of North Carolina, Chapel Hill, North Carolina. 10 A.M. – 4 P.M.; free. For more information, telephone (919) 962-1236.

MAY 26–28

International Amateur-Professional Photoelectric Photometry (IAPPP) Western Wing Group Annual Meeting

▶ Mile High Lake Arrowhead Resort, Lake Arrowhead, California. Contact Bob Bell, P. O. Box 1767, Lake Arrowhead, CA 92352, (909) 337-5080; e-mail, arrowheadbob@earthlink.net.

MAY 28–31

Riverside Telescope Makers Conference

▶ Camp Oakes, near Big Bear, California. Contact RTMC, 8300 Utica Avenue, Suite 105, Rancho Cucamonga, CA 91730; (909) 948-2205; website, http://www.rtmc-inc.org.

MAY 29

Hurricane Ridge Star Party

▶ Olympic National Park, Port Angeles, Washington. Contact John Gallagher at (360) 452-0260; fax, (360) 452-0256; e-mail, jgalla@orca.esd114.wednet.edu.

MAY 30–JUNE 3

American Astronomical Society Convention

▶ Chicago, Illinois. Contact Richard Kron, Yerkes Observatory, 373 West Geneva Street, Williams Bay, WI 53191; (414) 245-5555; e-mail, rich@oddjob.uchicago.edu; website, http://www.aas.org.

JUNE

Astronomy Camps

▶ Mt. Lemmon and Mt. Bigelow Observatories, University of Arizona, Tucson, Arizona. June 2–9, beginning teenagers; June 11–19, advanced teenagers; June 21–24, educators. Contact Don McCarthy, 933 N. Cherry Ave., Tucson, AZ 85721; (520) 621-4079, e-mail, dmccarthy@as.arizona.edu; website, http://ethel.as.arizona.edu/astro_camp.

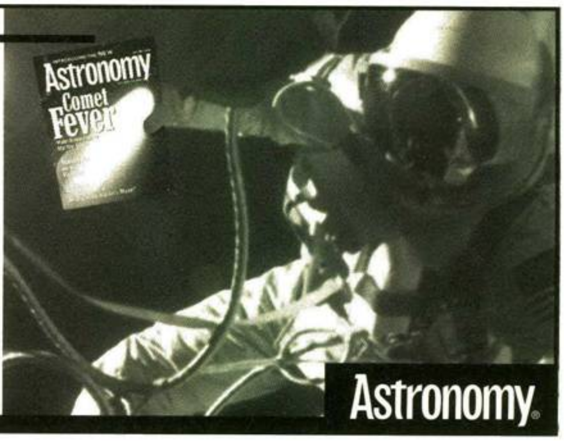
CONTACT

Please submit club announcements four months in advance to Looking Ahead, *Astronomy*, P.O. Box 1612, Waukesha, WI 53187-1612, or to tconley@astronomy.com. Look for additional events at http://www.astronomy.com.

Simply
out of
this world

Order your
subscription today!

Call 1-800-446-5489
www.astronomy.com

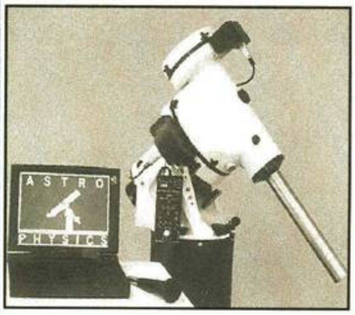


"GREETINGS STAR VOYAGER

Allow me to be your guide on a wonderful journey through the cosmos. I await your command."

Astro-Physics 1200GTO, 900GTO, 600EGTO German Equatorial Mounts with Servo Drive, Go-to Keypad, DigitalSky Voice™ Software

Imagine...a voice-activated, computer-controlled mount slewing from one end of the sky to the other with simple commands like "M1" or "Find Neptune."



1200GTO German Equatorial with Servo-Drive, DigitalSky Voice™ (Laptop not included)

- Zero-cogging, precision servo-motor with microprocessor control to an accuracy of ± 0.05 arc seconds per step
- Fast-slewing at 5 degrees per second
- Accurate sidereal motion ± 5 arc sec. periodic error
- Portable, very solid, vibration-free construction
- RA/Dec axes come apart without tools for easy transport
- Go-to keypad controller with PEM (permanent error memory), declination backlash control
- Ready for CCD autoguider and imaging cameras
- Ideal for CCD imaging and astrophotography
- Comes with DigitalSky Voice™ Software
- Fully compatible with Software Bisque's TheSky™

DigitalSky Voice™
Telescope Control System Software

DigitalSky Voice™ software ushers in a new era in telescope control systems. You can now establish two-way verbal communication with your mount, via your computer, slewing with ease from one object to another. Or, if you prefer, you can direct the movement of your scope with a few mouse clicks at the computer. Couple this revolutionary software with a superb Astro-Physics mount or any mount that uses the Meade protocol and enjoy a view of the universe from your own starship.

- Telescope slews to object you specify from extensive databases or any RA/Dec coordinate; or use common names such as "Find the Ring Nebula"
- Retain your dark adaption; eliminates need to look at your laptop
- Provides extensive information about object you view
- Easy two-star polar alignment
- Tours-predefined sequences of objects to view
- Intuitive computer interface, easy to use
- Use with Astro-Physics computer mounts or any mount that uses Meade protocol (LX200, LXD500, LXD650, LXD750)
- High coolness factor

DigitalSky Voice™ software

ASTRO-PHYSICS, INC, 11250 Forest Hills Rd, Rockford, IL 61115
Phone: 815-282-1513 Fax: 815-282-9847

ADORAMA INC.

42 WEST 18th STREET • NEW YORK, NY 10011

PHONE ORDERS ACCEPTED DAY OR NIGHT
• Mon–Thurs. 9 till 9:30 PM
• Fri. 9-1:45
• Sunday 9:30–6 EST

STORE HOURS:
• Mon.–Thurs. 9–7pm
• Fri to 1:45 • SUN 9:30–5:45

web:
www.adoramacamera.com

ORDER TOLL FREE • US & CANADA
800-7-ADORAMA
800-723-6726
ORDERS & INFO **212-647-9800**
FAX **212-675-8715**
CUSTOMER RELATIONS • 800-815-0702
• Mon–Thur. 9-4:30, Sun. 11-2 EST
E-mail: goadorama@aol.com

COMPLETE with MANUFACTURER'S ACCESSORIES

USED TELESCOPES

READY TO UPGRADE YOUR TELESCOPE?
CALL US FOR AN EVALUATION
LOOKING TO BUY A USED TELESCOPE?
We Deal in Previously Owned Telescopes & Spotting Scopes

CELESTRON®

SCHMIDT CASSEGRAIN

ULTIMA 2000	**Call**
Ultima 9¼ PEC	**Call**
Ultima 11 PEC	**Call**
CG-9¼	**Call**
New CM-1100	**Call**
New CM-1400	**Call**
Celestar 8	**Call**
Celestar 8 computerized	**Call**
Hand Control f/Celestar	**54.95**
Celestar 8 Deluxe	**Call**
8" S.C. Tube only	**649.95**
New G-8 German Eq. 8"	**Call**

Celestron
5" compact scope

C5+ 1250 F/10
Schmidt Cassegrain

C5+Telescope w/DC Drive	**Call**
C5 Spotting Scope	**Call**
C5 Tripod	**179.95**
Glass Solar Filter for C5	**69.95**
Radial Guider C5,C8	**84.95**
DEC Motor C5	**89.95**
JMI Focus Motor C5	**94.95**
Carry Case with Wheels for C5/C5+	**174.95**
Piggyback Counterpoise C5	**54.95**

New Compact 3.5" & 5" Schmidt Cassegrains
with Equatorial Mounts

G-3 3.5"	**499.00**
G-5 5"	**689.00**

Celestron Reducer/Corrector f/6.3

This combination focal reducer and field corrector lens accessory works with all Current Celestron and Meade Schmidt Cassegrains. Now it is possible to have a dual focal ratio instrument without sacrificing image quality. The Reducer/Corrector is f/6.3 for C8 and C11, f/7 for C14. A four element, fully multi-coated accessory. Results are amazing BOTH visually and photographically.

112.50

CELESTRON TELESCOPE ACCS.

AC Adpt. C5+, C8+ Ultima	**18.95**
Car Bat. Adpt. C5+,C8+ Ultima	**24.95**
2X Barlow 1.25" Short Tube	**44.95**
Counterweight Bar Assembly 8"	**84.95**
or 11"	**89.95**
Case for C8	**174.95**
Piggyback Mt 8"	**34.95**
Piggyback Bar Assembly 11"	**69.95**
Dewstar/Shade 8"	**24.95**
MOTORS	
JMI DEC C8+/Classic 8	**74.95**
JMI Focus C8+/Classic 8	**89.95**
Celestron Focus Motor	**109.95**
Single Axis Motor for CG-3	**109.95**
Single Axis Motor for CG-4	**109.95**
Single Axis Motor for CG-5	**114.95**
New Dual Axis Drive for CG-4	**159.95**
New Dual Axis Drive for CG-5	**169.95**
Dual Axis Drive for GP & CG5	**229.95**
ADVANCED ASTRO MASTER	
Advanced Astro Master for C8, Ultima-9-11	**489.95**
FILTERS	
LPR A	**59.95**
LPR B	**84.95**
Pol. Set 1¼"	**44.95**
Sky Filter #2	**44.95**
4 piece 1.25" FilterSet	**49.95**
Solar Filter Glass 8"	**99.95**
DIAGONALS	
Diagonal Erect 1.25" 45°	**34.95**
Diagonal Erect 1.25" 90°	**49.95**
Star Diagonal 1.25" 90°	**39.95**
2" Mirror Star Diagonal	**129.95**
FINDERSCOPES	
9x50 Finderscope Kit	**79.95**
6x30 Finderscope Kit	**45.95**
7x50 Polaris Finder Scope with Illuminator & Bracket	**159.95**
Quick Release f/7x50 find	**42.95**
Star Pointer Finderscope	**37.95**
Polar Axis Finder f/C4.5	**49.95**
Polar Axis Finder f/CG-4/5	**44.95**
Polar Axis Finder f/G-9/11/14	**124.95**
1.25" RACK & PINION FOCUSERS	
1.25" Focuser	**32.95**
GUIDING SYSTEM	
Radial Guider	**99.95**
Micro Guide Eyepiece	**144.95**
10mm Plossl Reticle	**84.95**
12mm Kellner Reticle	**64.95**
20mm Cross Hair Eyepce.	**34.95**
Pulsar Illuminator	**59.95**
Standard Illuminator	**39.95**
TRIPODS & MOUNTS	
Adj. Tripod Heavy Duty	**264.95**
Lightweight Tripod	**179.95**
Alt-Azimuth Mount	**149.95**
New CG-3 Equatorial Mnt.	**149.95**
CG-4 Equatorial Mnt.	**299.95**
CG-5 Equatorial Mnt.	**399.95**
New CZ-700 Mount	**1850.00**
Photo Tripod	**99.95**
Vibration Suppression Pads	**39.95**
NIGHT VISION ASTROLIGHTS	
Disposable Astrolite	**3.95**
Night Vision LED Light	**19.95**
T-ADAPTER/TELE EXTENDERS	
Tele Extender Deluxe	**48.95**
T-Adapt. f/Schmidt Cassegrains	**24.95**
T-Adapter/Barlow Lens 1.25"	**39.95**
T-C 16mm Adapter	**29.95**

CCD Filter Wheel Magazine only **319.95**

New! Pixel 237 CCD Camera **New Low Price**

CELESTRON ZOOM 1¼" EYEPIECES

Deluxe zoom Ocular 6.5-18mm Ortho	**145.95**

ULTIMA EYEPIECES

5mm, 1¼"	**69.95**
18mm 1¼"	**69.95**
42m, 1¼"	**89.95**
2X Ultima Barlow Lens	**Call**
7.5, 1¼"	**69.95**
24mm, 1¼"	**79.95**
35m 1¼"	**99.95**
12.5mm, 1¼"	**69.95**
30mm, 1¼"	**84.95**
Plossl 6.3,7.5,10,17,26	**44.95**
32, 40mm	**56.95**

PLOSSL EYEPIECES

6.3, 7.5, 12.5, 10, 17, 20, 26mm, 1¼"	**43.95**
32, 40mm, 1¼"	**49.95**

Vixen Lanthanum Eyepieces LV Series

2.5mm,	**109.95**
4mm	**117.50**
6mm	**94.95**
12mm	**109.95**
25mm	**109.95**
5mm	**94.95**
9mm	**94.95**
15mm	**94.95**
10mm	**94.95**
20mm	**109.95**
8-24mm Zoom	**164.95**

Pentax XL SMC Eyepieces

5.2, 7, 10.5, 14, 21, 28mm, 1.25"	**229.95**
40mm, 2"	**249.95**

Write or Call for a **FREE Binocular, Spotting Scope, Telescope Catalog**
Call **800-815-1259**
Ask for the Astro Catalog

CELESTRON

REFLECTORS

New C-150 Heavy Duty 6" Reflector	Call
C-114 HD *Premium Optics, CG-4 Heavy German Equatorial Mount with Adj. Aluminum Tripod, 6x30 Finderscope, 20mm Plössl Eyepiece*	**Call**
Firstscope 114 Deluxe	**Call**
Firstscope 114 Premium	**Call**

New C-114 HD 4.5" Heavy Duty Premium Reflector

New C-102 HD 4" Fully Multi Coated Heavy Duty Refractor

STAR HOPPER Dobsonian

4.5"	**219.95**
6"	**Call**
8"	**Call**
11"	**899.00**
14"	**1199.00**
17.5"	**2099.00**
6x30 LER Finderscope	**39.95**
Accessory Kits Available at Special Prices	**Call**

REFRACTORS

C-102 HD *4" Fully Multi-Coated Reflector, CG-4 Heavy German Equatorial Mount with Adj. Aluminum Tripod, 6x30 Finderscope, 20mm Plössl Eyepiece*	**Call**
New C102 HD Altazimuth	**Call**
New C80 Heavy Duty	**Call**
Firstscope 80 Equatorial	**Call**
Firstscope 80 W.A. Equat.	**Call**
Firstscope 70 Alt. Deluxe	**Call**
Firstscope 70 Equatorial	**Call**
Firstscope 60 Alt. Deluxe	**Call**
Firstscope 60 Equatorial	**Call**
Firstscope 60 Equatorial with Aluminum Tripod	**Call**

SPOTTING SCOPES

C90 MC w/1.25" Eyepiece	**Call**
Ultima 65 & 80	**Call**
15-60X Zoom	**Call**
New 80mm Wide Field with 2 Plossl Eyepieces	**Call**
500 f/5.6 Spotting Scope	**Call**
f/4 Adapter for 500/5.6	**74.95**
Moon Filter .96"	**9.95**

Tele Vue®

PLOSSLS		PANOPTIC		NAGLER	
8mm 1¼"	**82.00**	15mm 1¼"	**210.00**	4.8mm 1¼"	**175.**
11mm 1¼"	**82.00**	19mm 1¼"	**240.00**	7mm 1¼"	**220.**
15mm 1¼"	**82.00**	22mm 1¼"	**280.00**	9mm 2"/1¼"	**240.**
20mm 1¼"	**95.00**	27mm 1¼"	**330.00**	12mm 2"/1¼"	**340.**
25mm 1¼"	**95.00**	35mm 2"	**365.00**	16mm 2"/1¼"	**310.**
32, 40mm 1¼"	**110.00**	Panoptic Barlow Interface 2"	**90.00**	20mm 2"	**395.**
55mm 2"	**230.00**				

New POWERMATE 5X or 2.5X Image Amplifier...168.00

New RADIAN
3mm, 4mm, 5mm, 6mm, 8mm, 10mm, 12mm 14mm 1¼" **228.00**

BARLOW

Short Tube 2x 1¼"	**105.**
3X 1¼"	**105.**
Big Barlow 2x 2"	**168.**

ACCESSORIES

Bino-View Binocular Viewer.........**1030.00**

STAR DIAGONAL		RICH FIELD KIT		PARACORR	
2" Diagonal	**190.00**	with 55 Plossl 2" Diag., 2" to 1¼" Adapter	**410.00**	2" COMA CORRECTOR	**235.00**
1.25" Diagonal	**75.00**				
New 2" Premium Diagonal	**255.00**				

TELE VUE REFRACTORS

RANGER

PRONTO
70mm Aperture f/6.4 with ED Glass
925.00

101mm and 85mm REFRACTORS

101mm	**2760.00**
85mm	**1995.00**

BUSHNELL

60mm Zoom Refractor	**124.95**
60mm Zoom Refractor with Rotary Eyepiece	**134.95**

Bushnell Compact 4.5" Reflector ***$199.95***

Features a unique cradle mount which is convenient to use and transport. A wide field of view makes it easy to locate objects and keep them in view
• Aperture: 4.5" • Focal Length: 400mm
• Eyepieces: 1.25" 4mm (100X), and 25mm (16x)
• Focuser: Precision Rack & Pinion,
Tripod adaptable, includes convenient shoulder strap

SKYGAZER SERIES TELESCOPES

90mm SKYGAZER EQUATORIAL

Refractor Includes 3 high quaility 1.25" eyepieces (6.5, 10 and 25mm) Short tube Barlow, T-adapter, Adjustable tripod with tray, slow motion controls, 6x30 finder **279.95**

80mm Equatorial

910mm focal length (f/11.4) German Equatorial Mount, slow motion controls, setting circles, 25mm 1.25" eyepiece (36X), 1.25" diagonal, 6x30 finderscope, adjustable wood tripod .... only **284.95**

SKYGAZER 60 ALTAZIMUTH

Features a quality 700mm f/11 Refractor, **Two 1.25" Eyepieces,** 5x24 Finderscope, Hybrid 1.25" Diagonal, Adjustable Wood Tripod .... only **114.95**

SKYGAZER 60 EQUATORIAL

900mm f/15 Refractor, **Two 1.25" Eyepieces,** German Equatorial Mount, Slow Motion Cables, Setting Circles in both axes, 6x24, Finderscope, Hybrid 1.25" Diagonal, Adjustable Hardwood Tripod .... only **139.95**

SKYGAZER 114 (4.5)

Equatorial Deluxe Reflector Telescope

$239.95

114mm diameter Reflector with German Equatorial Mount, Slow Motion Controls in R.A. and DEC., 5x24 Viewfinder, Two 1.25" 25mm (36X) & 10mm (91X) Eyepieces, Adjustable Wood Tripod with Accessory Tray

NEW
STEREO BINOCULAR VIEWER $499.95

Close Outs

Sky Software Ver. 1.12 (PC)	**39.95**
Vista Pro (Mac)	**34.95**
JMI Motor Drive for MD 285/395/4500	**69.95**
Meade	
Epoch 2000 Image Process.	**74.95**
26mm Super Plossl Or. Vers.	**44.95**
Saturn 60 Equatorial	**109.95**
Astro Search 200 Software	**9.95**
12mm 1.25" Eyepiece	**19.95**
Saturn 114 (4.5") Eq.Ref.	**199.95**
60mm Altzimuth Ref.	**89.95**
Saturn 60 Altzimuth	**79.95**

Telescope Accessories

DEW SHIELD

Collapsible, fold down, easy to store and transport

for Celestron C90	**18.95**
f/8" Schmidt Cassegrains	**28.95**
f/5" Scopes	**24.95**
f/10" Schmidt Cassegrains	**38.95**
f/11" Scopes	**49.95**

LUMICON FILTERS

BUY ANY 2 FILTERS AND TAKE 7% OFF THESE PRICES
UHC Premium, Deep Sky Premium, H-Beta or Oxygen III

1¼"	**99.50**
2" Rear Cell	**199.95**
48mm	**199.95**
2" T Mount	**199.95**

TELRAD FINDER

TELRAD with Base	**36.95**
Dew Shield for Telrad	**11.95**
Spare Mounting Base	**7.95**

EASY TESTER

Optical Evaluation Eyepiece	**29.95**

JMI FOCUSERS

NGF-DX1	**229.**
NGF-DX2	**169.**
NGF-4	**99.**
NGF-DX3	**139.**
NGF-S w/Motofocus	**239.95**

THOUSAND OAKS SOLAR FILTER

Stainless Steel Coated (Type 2 & Type 2 Plus)

for Celestron C90's	**Call**
for Televue Genesis/101	**Call**
for Pronto/Ranger	**Call**
for Celestron C5's	**Call**
for Schmidt Cassegrains 8"	**Call**
for Meade 10"	**Call**

WE SHIP PROMPTLY. ALL TELESCOPES INCLUDE U.S.A. WARRANTY

No Surcharge for MasterCharge or Visa Purchases. Personal checks welcome, will ship without delay. Name must be imprinted on check, also include address, phone, and a copy of major credit card or driver's license for reference. Shipping, handling and insurance additional. 14 day money back guarantee less shipping, with packing and blank warranty card, except film and paper. We ship UPS. Some items special order. All orders are subject to acceptance and verification. Second hand dealer's license #802862. Pictures are for illustration purposes only and may not be exact. Wa are not authorized Meade dealers.

Prices effective till April 20, 1999 **Please address all inquiries and orders to ASTRO. DEPT. #55**

ADORAMA

42 West 18th Street • New York, NY 10011 5
www.adoramacamera.com

ORDER TOLL FREE **800-723-6726**
ORDERS & INFO **212-647-9800**
FAX # 212-675-8715

BBB MEMBER METROPOLITAN NEW YORK

The only Astronomy Dealer in New York Endorsed by the B.B.B.

BINOCULARS

Adorama Provis Series Binoculars

New Lower Prices

Deluxe, Lightweight with enhanced Multi-Coating. Full-sized binoculars in a compact and lightweight high-quality cast-aluminum alloy housing with a soft leatherette covering.

- BAK-4 glass porro prisms.
- Full Multi-Coating. Every air-to-glass surface is multi-coated to increase light transmission, better image contrast and color balance
- Soft grey leatherette covering
- Threaded to accept tripod adapter
- Long Eye Relief. ideal for eyeglass wearers
- Roll down rubber eyecups
- Supplied with Deluxe Hard Carrying Case
- Rated "Exceptional Inspection Standard" by the Japanese J.T.I.I.

PROVIS Binocular	Eye Relief	Field of View	Near Focus	Size HxW	Weight oz.	Price
8x24	16mm	6.5°	16'	4.92" x 6.85"	22.2	**139.95**
7x50	23mm	6°	26'	6.42" x 7.24"	27.8	**139.95**
10x50	16mm	5.3°	26'	6.22" x 7.24"	27.8	**149.95**

NIGHT VISION

BINOCULARS

30,000X 4X Magnification....................399.95
Compact Binocular 30,000X 4X Mag. 399.95
30,000X Goggles 1X Mag. Focuses as close as 9" ..599.95

MONOCULARS

5X Compact Monocular with 10,000X Light Magnification 279.95
Ultra Compact 2X (15000X)....................219.95

TASCO

NV-360 **Monocular**....................294.95
Camera Adapter for 360 ....49.95

Night Owl

Night Owl NZTI™

164.95

- 1400x light amplification
- 2.4x image magnification with high quality large objective lens to gather light. • Camera adapter and infrared illminator included

ASTRONOMY BOOKS

Books for Beginners

Nightwatch: Equinox Guide ...**24.95**
Astronomy: Self-Teach Guide **17.95**
Deep Sky: An Introduction **24.95**

Binocular Observing

Exploring the Sky by Moeschel....................**19.95**
Binocular Astronomy........**24.95**
Touring the Universe Through Binoculars......**28.95**
Deep Sky Objects **8.95**

Star Atlases

Sky Atlas 2000 Field Ed. ...**29.95**
Laminated Sky Atlas 2000 Field Edition....................**64.95**
Sky Atlas 2000 dlx. New Ed. .**49.95**
Sky Catalogue 2000. Vol. 1 or 2 2nd Ed. (paperback)......**39.95**
Bright Star Atlas 2000 ......**10.95**
Celestron Sky Map **16.95**
Atlas of Deep Sky Splendors 4th Edition....................**24.95**

Uranometria 2000 ....**39.95**
Deep-Sky Field Guide to Uranometria 2000 ....**49.95**

Observers' Handbooks

The Backyard Astronomer's Guide....................**29.95**
Star Hopping by Macrobert...**19.95**
City Astronomy....................**18.95**
Burnham's Celestial Handbook 3 Volume Set....................**39.95**

Astrophotography & Imaging

Astrophotography II **18.95**
Choosing & Using a CCD Camera w/ 3.5" Disk.......**29.95**
Introduction to Astro. Image Processing **29.95**
CCD Camera Cook Book.....**29.95**

Building Telescopes

How To Make A Telescope **19.95**
Build Your Own Telescope.....**24.95**
Starware by "Harrington" .**19.95**
Making your own Telescope **9.95**
Telescope Building w/Dobson Video Tape...**39.95**

Night Navigator $99.95
The Electronic Star Locator

Locates and Identifies Constelations Quickly.

- Scientific patentedcomputer tracking system to accurately locate and identify constellations, planets, and stars quickly and effortlessly.
- Innovative built-in digital electronic compass automatically plots your location.

ASTRONOMY SOFTWARE

Red Shift 3
(PC) **44.95**
(MAC) **46.95**

THE SKY
for Windows 95

Sky Level 2 or 3..........**Call**
Sky GSC (CD ROM) Level 4....................**Call**
LX-200 Interface....**24.95**
Our Solar System..............**18.95**
Encyclopedia of Space & Universe **37.95**

PRO OPTIC BINOCULARS

Now includes 25 YEAR WARRANTY

These binoculars with their large objectives high quality BAK-4 prisms will provide you with breathtaking wide-field observation of astronomical objects as well as terrestrial viewing under low light conditions.

Each binocular is provided with a high quality Hard Case, Neck Straps and Rubber Eye-Cups.

70mm Jumbo Fully Multi-Coated Series

11x70 Jumbo – 4º field of view, 21mm eye relief, weighs 2.8 lbs. ..**159.95**
16x70 Jumbo– 3.6º field of view, weighs 2.8 lbs. **169.95**

80mm Giant Fully Multi-Coated Series

11x80 Giant – 4.2º field of view, 14mm eye relief, weighs 5.25 lbs. **249.95**
20x80 Giant – 3.3º field of view, 14mm eye relief, weighs 5.25 lbs. **259.95**

100mm Ultra Giant Series

The ultra large aperture of 100mm provides more than 50% more light gathering power than the standard 80mm Giant Binoculars. For a delightful experience in astronomical viewing.

Both feature multi-coated optics, BAK-4 prism, built-in platform which mounts on a tripod.

14x100 Ultra Giant....**849.95** **25x100** Ultra Giant.....**899.95**

FUJINON FMT-SX Binoculars

10x70

7x50 FMT-SX with Carry Case & fashion strap....................**Call**
7x50 FMTR-SX ....**Call**
7x50 FMTR-CSX R.C.with Compass & fashion strap ....**Call**
8x30 FMTR-SX Rubber Coated & fashion strap....................**Call**
10x70 FMT-SX with Carry Case & fashion strap....................**Call**
16x70 FMT-SX with Carry Case & fashion strap....................**Call**
Tripod Adapter – Large **19.95**
8x42 BFL .**229.95** **10x42** BFL ..**234.95**

CD WATERPROOF

7x42 ...**Call** **8x42**....**Call** **10x42** .**Call**

GIANT BINOCULARS

25x150 ED EM....................**Call**
25x150 EM ....**Call**
40x150 ED MT....................**Call**

Fieldscope Super 80

Super 80 with 20X-60X ....**Call**
Super 80 ED with 20X-60X ....**Call**

CANON

Image Stabilized

10x30 ...**389.95** 12x36 .**599.95**
15x45 ....**999.95**

PENTAX PCF

7x50........**120.00** 8x40....**120.00**
10x50......**135.00** 12x50..**137.00**
16x50......**144.00** 20x50..**160.00**

LEICA

w/USA Passport Warranty

10x50 BA .**Call** 8x50 BA......**Call**
12x50 BA ....**Call**
7x42 GEOVID BDA ....**Call**
7x42 GEOVID BD ....**Call**

KOWA

82mm Spotting Scopes (Body only)

TSN-821.....**399.95** TSN-822 .**364.95**
TSN-823.....**899.95** TSN-824 .**869.95**

82mm Scopes with 20-60X Zoom

TSN-821 with 20-60X Zoom...**639.95**
TSN-822 with 20-60X Zoom...**609.95**
TSN-823 with 20-60X Zoom.**1139.95**
TSN-824 with 20-60X Zoom.**1119.95**

CELESTRON

GIANT MULTI-COATED

20x80 Basic ...**Call** 20x80 Dlx ..**Call**

REGAL

8x42 ....**Call** 10x50 ....**Call**
6.5x44 **ED**....................**289.95**

ULTIMA SERIES

7x50..............**Call** 8x40. ....**Call**
10x50...........**Call** 8x56 ....**Call**
New 9x63 .....**Call**

PRO SERIES w/Focus Lock

7x50 ....**94.95** 8-24x50**139.95**

NEW ADVENTURER

7x50 ....**119.95** 8x32 ......**99.95**
10x50 ....**Call** 8-32x50 ...**Call**

MINI M/C with Case

8x21 ....**39.95**
10x25 ....**49.95** 7-16x25 **75.00**
MONOCULAR– 8x25............**39.95**
Telescope/Monocular **39.95**

BUSHNELL

Discoverer 15-60 X60 ......**179.95**
Camera Mount f/Discoverer **14.95**
Spacemaster **149.95**
Spacemaster Rubberized **163.95**
Spacemaster Kit w/15-45X, Tripod and Case **247.95**
Elite 60mm w/15-45X Zoom **Call**
Elite 77mm....................**269.95**
Eyepieces & Accessories ....**Call**

PRO OPTIC
Astronomical Accessories

A unique combination of high quality and economical prices

Pro-Optic Plössl 1.25" Eyepieces

- Sharp detail • High contrast ghost-free images • Wide 50° apparent field of view (43° on the 40mm Plössl)
- 4 element optics
- Lens edges are blackened to keep out reflected light
- Accepts 1.25" filters.

MULTI-COATED PLÖSSL EYEPIECES

40mm....**49.95** 32mm **49.95**
25mm....**34.95** 17mm **34.95**
12.5mm.**44.95** 10mm **34.95**
7.5mm...**34.95** 6.3mm ...**44.95**

Fully coated Plössl

20mm Plössl 1.25" **24.95**

Rubber Eye Guard for 6.3-25mm plössl Eyepieces.............**2.49**

Short Tube Barlow

Double the power of any eyepiece with this Barlow. Only 2¼" long. Works with all type of telescopes, including Refractors and Reflectors
only **$39.95**

Pro Optic 500mm f/5.6 Maksutov Telephoto/Spotting Scope

with High-Tech White Finish

Carry Case

Multi-coated to maximize contrast and sharpness and a built-in field flattener to reduce field curvature.
With its 500mm focal length, it is long enough for close-ups of far away objects but with the f/5.6 optics it is fast enough to be hand held, focuses as close as 5 feet.
With the addition of the SS500 Kit you can convert it to a 20X 90mm spotting scope. The SS500 kit includes a 45° 1.25" Erect Image Diagonal and a 25mm 1.25" Plossl

Pro-Optic 500mm f/5.6 lens **209.95**
Pro-Optic SS500 Kit (when purchased w/500/5.6).......**49.95**
350mm f/4 Converter for 500/5.6 ....**74.95**

PRO OPTIC

New 15-45x Fieldstar Spotting Scope Outfit

Fully Coated, 2.25° f.o.v. at 15x, Long Eye Relief (33mm @ 15x) weighs only 25 oz,
• Rubber Coated includes Case & Table Top Tripod

139.95

Pro-Optic Slow Motion Control ***29.95***

Make accurate slow motion adjustments in altitude and Azimuth. In addition the Pro-Optic SMC allows you to make major adjustments in elevation with a separate control knob.The Slow Motion Control fits any tripod with 1/4-20 thread.

Pro-Optic 45º Erect Image Diagonal

Provides an ideal 45° angle for erect image terrestrial viewing

45° Erect 1.25" **34.95**
45° Erect Hybrid (1.25" to .96")....................**34.95**
90° Star Diagonal 1.25" **34.95**
New Straight Through Erector (Porro Prism) **64.95**

EYEPIECE FILTERS 1.25"

Available in the following colors: 1A Skylight; 8 Yellow; 11 Yellow Green; 12 Deep Yellow; 15 Deep Yellow; 21 Orange; 23A Red; 25 Red; 47 Violet; 56 Light Green; 58 Green; 80A Lt. Blue; 82A Pale Blue; ND 0.3; ND 0.6

1.25" .....Ea. **9.95** Moon Filter 1.25" (ND 9X) **11.95**
Buy any 4 filters (1.25") ....for only **34.95**
Buy any 12 filters ....for only **99.95**

4 Piece Filter Set with Pouch

Set #1 includes: #12, 23A, 58 & 80A Packaged in a Pouch **34.95**
Set #2 includes: #11, 25A, 47 & 82A **34.95**

SEE OPPOSITE PAGE FOR ORDERING INSTRUCTIONS

Astronomy's
Retail & Travel Directory

RETAIL SHOPS

ARIZONA - Phoenix 85032

THE ASTRONOMY SHOP

Telescopes:
Meade, Celestron, Tele Vue®, Orion, Takahashi
Spotting Scopes • Binoculars • Eye Pieces & Accessories
Maps • Books • Sky Tours
astroshop@earthlink.net www.darkskyinc.com
3202 E. Greenway Rd. Suite 1615 (602) 971-3170

FLORIDA - Tampa 33612

THE FAMILY ASTRONOMER

Telescopes • Binoculars • Eyepieces • Accessories
Specializing in "Family" Astronomy!
Celestron • Meade • CCD • Software
Expert help in choosing the right telescope.
hjastro@gte.net Fax: 813-948-3373 Info: 813-948-3434
922 E 124th Ave., Suite D. (Orders Only): 800-537-2866

FLORIDA - Sarasota 34236

WOLF CAMERA

Telescopes
Meade
Celestron
Tele Vue®

WOLF CAMERA

CCD Equipment
Meade Pictor
Optec Max.
Accessories

The Largest Telescope Dealer in the Southeast!
New & used telescopes, CCD equipment & accessories, plus a huge selection of eyepieces and binoculars! Call Chuck Pisa our staff Astronomer with 20 years experience today!
www.wolfcamera.com Fax: (941) 952-0278
1055 S. Tamiami Trail (941) 957-4686

GEORGIA - Atlanta 30306

Camera Bug Ltd.

Telescopes • Binoculars • Accessories • Eyepieces
Spotting Scopes • Maps • Books • Canon • Celestron
Meade • Minolta • Olympus • Orion • Pentax • Tele Vue®
We ship almost anywhere! www.camerabug.com
fax: (404) 873-3925 *ORDERS ONLY*: (800) 545-8509
1799 Briarcliff RD (404) 873-4513

NEW YORK - Amityville 11701

BERGER BROS.

CAMERA & VIDEO EXCHANGE
"Serving New York For 50 Years!"

TELESCOPES • BINOCULARS • CAMERAS
CAMCORDERS • DIGITAL CAMERAS
We Carry: Celestron • Bausch & Lomb • Nikon • Canon
Meade • Pentax • Minolta • Olympus • Leica • & More!
Catalog Available • We Ship Worldwide
http://www.berger-bros.com Fax: (516) 264-1007
209 Broadway (Route 110) (800) 262-4160

You can affordably attract customers straight to your door with an ad in

Astronomy's Retail & Travel Directory

Learn more about this targeted advertising opportunity call
Scott Redmond at 1-888-558-1544 ext. 487.

RETAIL SHOPS

TEXAS - San Antonio 78250

Analytical Scientific

"The Source For All Your Astronomy Needs"

Telescopes:
Schmidt-Cassegrain • Refracting • Meade • Maksutov
Dobsonian • Celestron • Tele Vue® • Bushnell • JMI
Binoculars • Spotting Scopes • Laser Sight
Celestron • Swift • Bushnell • Meade
Microscopes: Swift • Eagle
E-Mail: asltd@analyticalsci.com
http://www.analyticalsci.com Fax: (210) 520-3344
11049 Bandera Rd. (800) 701–STAR (7827)

WISCONSIN - Middleton 53562

EAGLE OPTICS

Celestron, Meade & Tele Vue®
Telescopes & Accessories in stock!
Shipping Nationwide!
Discount Price List & Comprehensive Catalog.
www.eagleoptics.com
2120 W. Greenview Dr. #4 (800) 289-1132

CANADA - Ontario - Toronto M6A 3A4

EfstonScience

SERVING OBSERVING SINCE 1970!

Just look for the giant telescope on our roof!

MEADE APD CELESTRON

Science & Astronomy Superstore.
All major brands on display. Free Literature.
We welcome trade-ins, buy used, do service.
Dobsonians in stock: 6" - 17 1/2"
www.efstonscience.com Fax: (416) 787-5140
3350 Dufferin St. (416) 787-4581

Call 1-888-558-1554, ext. 487 for advertising information.

CANADA - Ontario - Toronto M6A 2T2

KHAN SCOPE CENTRE

MEADE APD PRODUCTS

Our 12th Year!

We Ship!
New and Used
Trade - Ins

Meade • Celestron • Tele Vue ® • Omcon • Optec
B&L • JMI • Swift • Leica • Kendrick • Antares
Canon • Swarovski • Lumicon • SBIG • Fujinon • Telrad
Thousand Oaks • Sky Publishing • Speers-Waler
and many others!
FREE DISCOUNT PRICE LIST
Visit our web site: www.khanscope.com
e-mail: khan@khanscope.com *Fax:* (416) 783-7697
3243 Dufferin St. (416) 783-4140

Astronomy's
Classifieds

ACCESSORIES FOR SALE

Equatorial platform kits. New Altazimuth platform has tracking and GOTO. PC autoguiding for astrophotography. Binocular viewer kits. TL Systems, 2184 Primrose Avenue, Vista, CA 92083. (760) 599–4219. tlsystem@ix.netcom.com or http://www.netcom.com/~tlsystem/

Meade Telescope Baseball Caps & Coffee Mugs and more. Free catalog of full color, personalized gifts. T-shirts, mouse pads, coasters, walnut clocks, etc. Web Page: www.galaxymall.com/gift/switzertech or write to: Switzer Technologies, Inc., PO Box 570, South Holland, IL 60473-0570.

DOMES & PORTABLE STRUCTURES

DarkSite Domes temporary structure status, transportable, classic dome styling, rugged construction. www.darksitedomes.com or 800-526-3887 for brochure.

EDUCATION

Free Star Charts for teachers K-12. Tell your teacher! Astronomical Data, PO Box 26180, Colorado Springs, CO 80936.

Teen Astronomy: Kopernik Observatory and SUNY host residential astronomy institutes for grades 7-12: telescope work, CCD imaging, computer interfacing. Kopernik Observatory, 698 Underwood Rd, Vestal, NY 13850. 1-888-269-5325, www.kopernik.org.

MISCELLANEOUS FOR SALE

Astronomical Art by Gary Escobedo. Free photographs available. Send SASE to 10465 Nashville Ave., Whittier, CA 90604. (562) 903–3932

Observatory Host Needed– Idaho's Bruneau Dunes State Park needs someone to help develop and present astronomy programs. Volunteer host will work with new 25" Obsession telescope. Campsite provided. (208) 366–7919.

SERVICES

Help solve 1908 Tunguska impact mystery. New theory supposes metallic hydrogen crystal. Modest telescope okay. Free location possibilities on request: Gauntlet books, Box 499, Franklin, MA 02038.

TELESCOPES FOR SALE

Celestron CG11 Mint! Includes Polar Finder, 12v battery, Dew shield, Telrad, Lumicon Giant easy guider/ reducer/ DS Filter, piggyback bracket. $2999.00 Call Larry, (908) 771–5586.

Celestron RF80 spotting scope, 1 year old, $250 OBO, no accessories. David, Greenfield, WI (414) 282–3700.

Close Encounters Telescopes: Telescopes, accessories, spotting scopes and more! Ph:(403) 818–4424. Email: telescope@3web.net. 5005 Macleod Trail South, Calgary, Alberta T2G 0A9.

Questar seven. Folding pier, wedge, PowerGuide II. Last one sold new in December 1998. There are no more to sell. Full factory warranty corrected all adjustments and glitches. Perfect. Own a piece of Questar history. For details call Bill (703) 354–6199. $12,500 or trade for perfect 3.5 Duplex or Meade 16".

Two inch Crayford focuser, $59. Four inch F-4 O.T.A., $220. (909) 778–0589.

TELESCOPES WANTED

Wanted: used telescopes and accessories. Contact Gary Hand, 24045 Sugarcane Ln., Gaithersburg, MD 20882. (301) 253–5046.

ASTRONOMY Word Classified Advertising

Use this form or a sheet of paper for your ad. Print neatly and clearly.

Not responsible for errors due to illegible copy. There is no additional charge for punctuation.

- CHECK APPROPRIATE BOX -

- ☐ Accesories For Sale
- ☐ Accessories Wanted
- ☐ Astrophoto Equip. For Sale
- ☐ Astrophoto Equip. Wanted
- ☐ Binoculars For Sale
- ☐ Binoculars Wanted
- ☐ Books & Periodicals For Sale
- ☐ Books & Periodicals Wanted
- ☐ CCD Equipment For Sale
- ☐ CCD Equipment Wanted
- ☐ Communications Wanted
- ☐ Domes & Portable Structures
- ☐ Education
- ☐ Employment
- ☐ Lodging/Tours/Trips
- ☐ Misc. For Sale
- ☐ Misc. Wanted
- ☐ Organization Announce.
- ☐ Services
- ☐ Software For Sale
- ☐ Software Wanted
- ☐ Telescopes For Sale
- ☐ Telescopes Wanted
- ☐ Videos For Sale
- ☐ Videos Wanted

Rates: $1.53 per word, $14.00 minimum per ad, issue and insertion. *Call for frequency discounts. Payment MUST accompany ad. We accept check, money order or credit card. U.S. Funds ONLY. Ads not received in time will automatically run in the next issue unless otherwise specified. All ads subject to approval. Mail to:

Astronomy Classified Ads
21027 Crossroads Circle • PO Box 1612 • Waukesha WI 53187-1612
or call 1-888-558-1544 ext 815
FAX: 414-796-0126

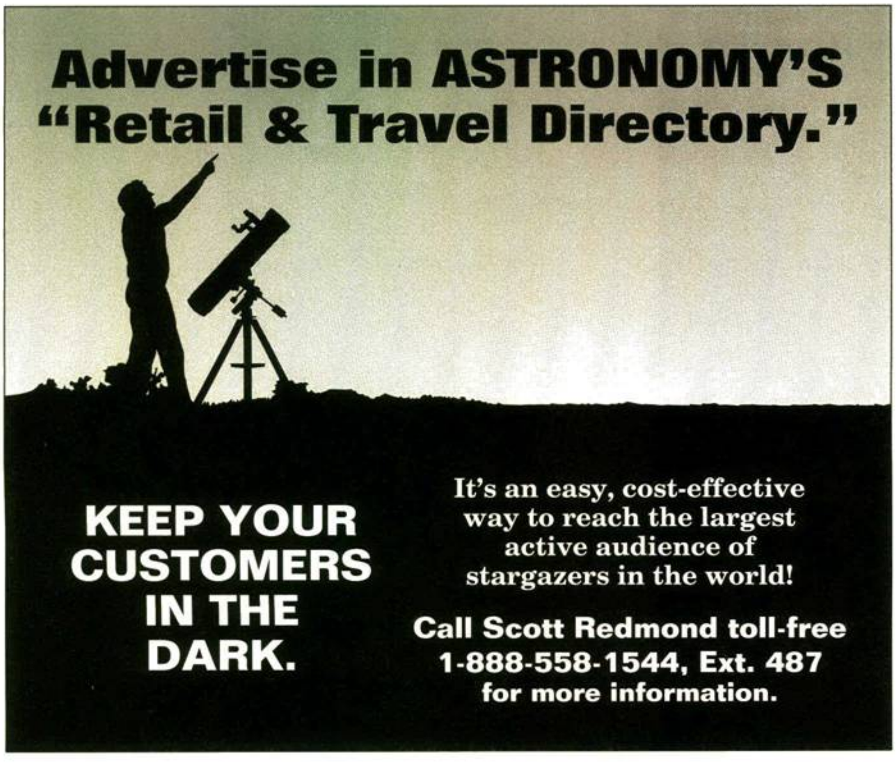
IMPORTANT - If you use a box number as your address in your ad, we require - for our records only - your complete name and street address.

NAME ____________________
STREET ____________________
CITY, STATE ____________________
ZIP ________ PHONE: ( ) ____________

Total # of words ____________
Ad rate per word $1.53
Subtotal ____________
# of insertions* ____________
TOTAL ____________

☐ MasterCard ☐ VISA ☐ American Express Card ☐ DISCOVER

CC # ____________________ Exp ________



Advertise in ASTRONOMY'S "Retail & Travel Directory."

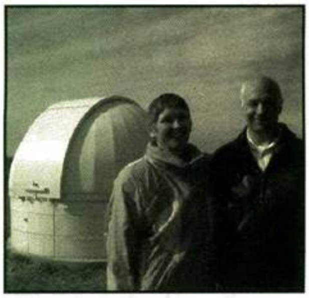
KEEP YOUR CUSTOMERS IN THE DARK.

It's an easy, cost-effective way to reach the largest active audience of stargazers in the world!

Call Scott Redmond toll-free 1-888-558-1544, Ext. 487 for more information.

ADVERTISER PROFILE

"Astronomy is worth the investment!"



Meg and John Menke

Technical Innovations, Inc.
22500 Old Hundred Road
Barnesville, MD 20838
301-972-8040
www.homedome.com

"Over 85% of our sales come from serious amateur astronomers," says Meg Menke, owner of Technical Innovations, Inc. "We advertise in *Astronomy* to reach them!"

Technical Innovations manufactures affordable fiberglass observing domes and remote control automation. These domes allow amateur astronomers to have a permanent setup for their astronomical equipment in their own backyards. This unique product helps increase overall observing time.

"Since 1992, we've been advertising in *Astronomy* with consistent results," Meg says. "Even though *Astronomy* is a U.S. magazine, it has an international circulation. This helps us sell our product to amateur and professional astronomers around the globe—our target market. It's worth the investment!"

Advertise in *Astronomy!*

For more information call toll free:

1.888.558.1544

Outside the U.S. and Canada call 414-796-8776

Advertising Sales Manager
Dan Koehler, ext. 628

Advertising Sales Rep.
Michael Ellis, ext. 636

Retail and Travel Directory
Scott Redmond, ext. 487

www.astronomy.com

3563-9905

NEXT month in Astronomy

NASA

CATCHING COSMIC GHOSTS

So elusive they zip through Earth unscathed, neutrinos carry vital information about the sun's core, supernovae, gamma-ray bursts, and other inaccessible areas.

TAIL OF THE SCORPION

Neglected for too long, the rich star clusters and bright nebulae of southern Scorpius promise summer observing fun.

MOUNTAINS OF DATA

Forget megabytes and gigabytes — new telescopes are bringing terabytes of information to Earth. Will astronomers ever be able to study it all?

THE COSMIC DJ

John Kraus designed the Big Ear radio telescope, which surveyed the sky and expanded the size of the known universe.

To get your copy of the June issue, visit your local hobby shop or newsstand, or call

1-800-533-6644

Kalmbach Publishing Co., P.O. Box 1612,
Waukesha, WI 53187-1612

Visit our web site at
www.astronomy.com

AD INDEX

Adirondack Video Astronomy 101
Adorama 118, 119, 131
Anacortes Telescope & Wild Bird 131
Analytical Scientific 131
Apeiron 101
Apollo-Foco International, Inc 113
Arcron Zeit 115
Astronomics 91
Astronomy Book Club 19
astronomyone.com 102
Astronomy Shoppe 131
Astro-Physics 102, 117
Astro Stuff 104
Astrosystems, Inc 104
Beigle/Bryant Engineering 102
Bethany Sciences 103
Boeckel's Astronomical Supplies 102
Boyd Observatories 103
CC Sales/Camera Corner, Inc 131
Cambridge University Press 107
Camera Bug 131
Captain's Nautical Supplies 131
Casper, Michael I Meteorites 105
Celestron International 34, 35, 36, 37
Cruise Holidays 105
Davis Instruments 115
Day Star 111
DestinySpace 102
Discovery Telescopes, Inc 102
Eagle Optics 131
Earth Treasures 103
Eclipse Edge Expeditions 113
Edmund Scientific Company 21
Edward R Hamilton Bookseller 101
Exotic Expeditions 101, 102
F C Meichsner Company 27, 131
Focus Camera 76, 77, 131
Glatter, Howard 103
Innovations in Travel 105
Into the Wind/The Kite Source 103
JMB, Inc 29
Jensan Educational Products 104
Jim Kendrick Studios 115
Jim's Mobile Industries 97
Kalmbach Publishing Co 90, 100, 114, 121, 122, 123
L&S Astronomy Tours 103
Le Sueur Manufacturing, Co. 115
Lumicon 94, 95, 131
Mag One Instruments 105
Marketplace Pages 101, 102, 103, 104, 105
Meade Dealer Pages 16, 17
Meade Instruments Corp 2, 3, 7, 8, 9, 10, 11, 12, 13, 14, 15, 134
Minerva Press 104
Mountain Skies Astronomical Society 104
Murnaghan Instruments 111
Newport Glass Works 103
Nisur Systems 105
Novagraphics 102
Oceanside Photo & Telescope 20, 131
Orion Telescopes & Binoculars 23, 84, 85
Out&About Travel Advisors, Inc 104
Outer Edge Expeditions 101
Parkside Optical 27
Pocono West Optics 88, 89, 131
Psignologic Services 104
QSP Optical Technology, Inc 101
Radio City 105
Rainbow Optics 101
Rainbow Symphony 105
Retail & Travel Directory 120, 121
Rivers Camera Shop 29, 131
Roger W Tuthill, Inc 27, 104, 105, 109
Samy's Camera 31
Santa Barbara Instrument Group 33
Science Connection, Inc. 103
Scope City 31, 131
ScopeTronix 105
Shutan Camera & Video 99
Sienna Software 29
Software Systems Company 20
Sovietski Military Collection 103
Star Hill Inn 104
Starsplitter Telescopes 103
Swinburne University Of Technology 27
T & T Binocular Mounts & Beyond LLC 102
The Teaching Company 25
Tech 2000 104
Technical Innovations 27
Tele Vue Dealer Page 131
Tele Vue Optics, Inc 132, 133
Thousand Oaks Optical 111
Travel Quest 103
Travel Wizard 101
Treasures of Turkiye 105
University Optics, Inc. 109
Virgo Astronomics 105
W B Hunt Co., Inc. 131
What in the World 101
Wholesale Optics 113
Willmann-Bell, Inc. 105
Woodland Hills Photo Images 131

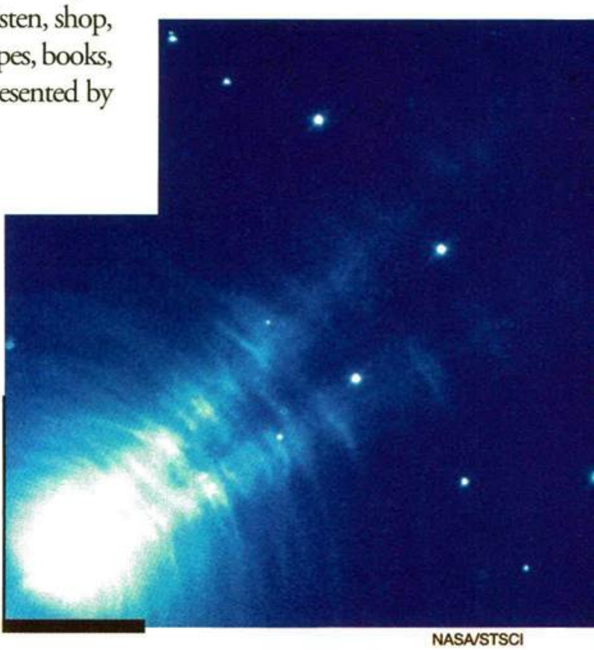
Attend an event with universal appeal!

Universe '99: Partners in Astronomy

The premier exposition and conference for amateur and advanced astronomers.

July 3–4, 1999 Toronto, Canada

This year Universe '99 returns to Canada at the beautiful University of Toronto. Join thousands of other astronomy fans to learn, listen, shop, wonder, and share! Vendors will be on hand with the telescopes, books, and accessories you're looking for. Plus, come to lectures presented by the leading astronomers of today.



NASA/STSCI

Featured speakers include:

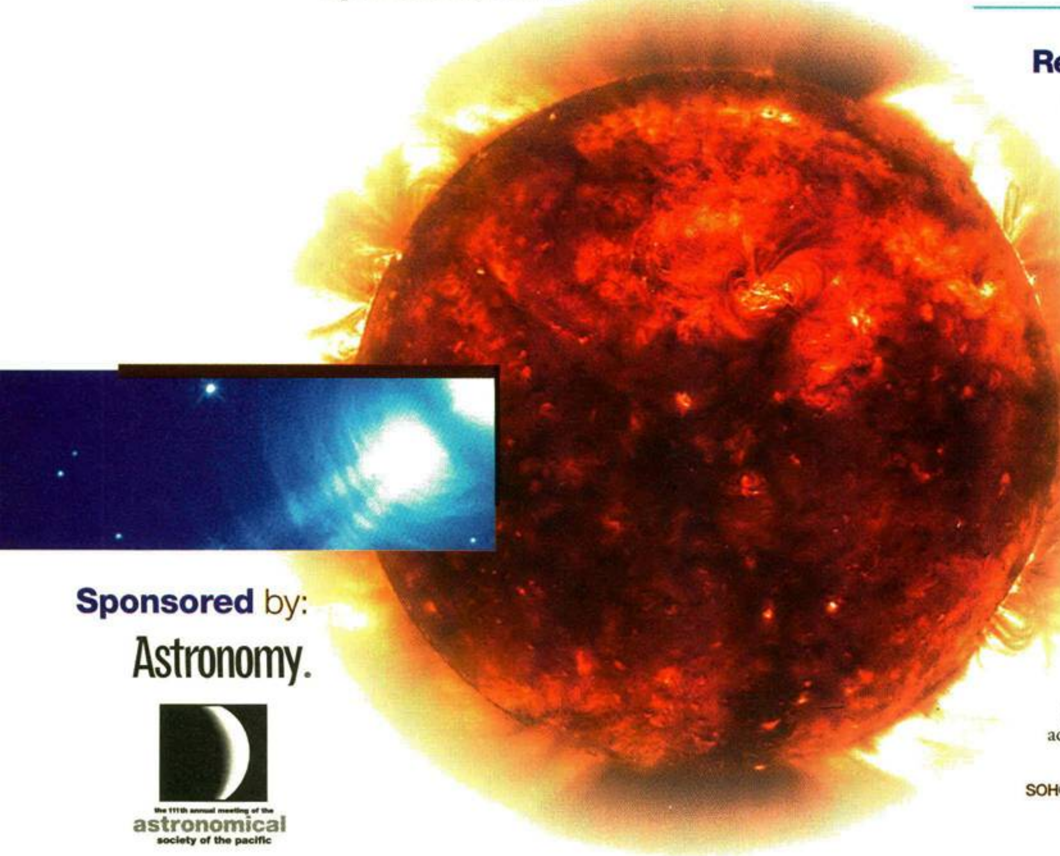
Alexei Filippenko, University of California–Berkley
Topic: Supernovae

Edward W. Kolb, Fermi National Accelerator Lab
Topic: Cosmology

Jack Newton, Florida Imaging Center
Topic: CCD Imaging

Sallie Baliunas, Harvard-Smithsonian CfA
Topic: Our Star, The Sun

Tom Bania, Boston University
Topic: Astronomy in Antarctica



SOHO/NASA/ESA

Register today for Universe '99!

Only $20 for the full weekend.
Children under 12 free.

Call, write, or e-mail us at:
Annual Meeting A.S.P.
390 Ashton Avenue
San Francisco, CA 94112

Phone: (415) 337-1100
Fax: (415) 337-5205

E-mail:
lkeechler@aspsky.org

www.aspsky.org

Special travel and lodging discounts are available from Quality Inn, Radisson Hotels, Air Canada Airlines, and AVIS Car Rental. For details, contact Laurie Keechler at the e-mail address or phone number above.

Sponsored by:

Astronomy.

the 111th annual meeting of the
astronomical
society of the pacific

University of Toronto, American Association of Variable Star Observers (AAVSO), Royal Astronomical Society of Canada (RASC)

3352-9904

OBSERVING THRILLS

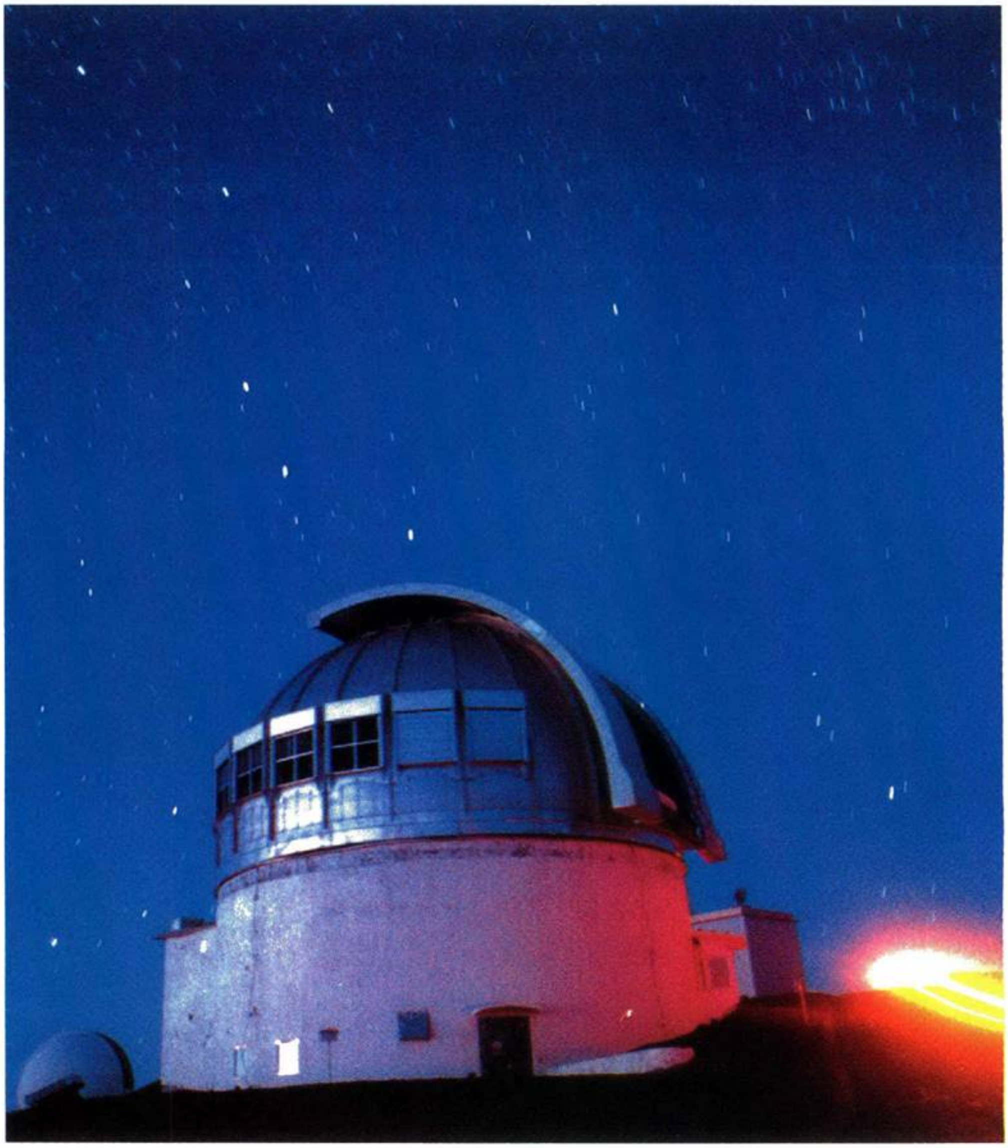
Seven Hours on Mauna Kea

▶ On a family vacation in Hawaii, I had to see the world's best night sky. Although no one grants permission to visit Mauna Kea after dark, the site is open and unpatrolled.

There are a couple ways to the summit, which sits nearly 14,000 feet above sea level on Hawaii's Big Island. One is to pay a stiff fee to private operators who bring tourists from resort hotels. The other is to bring your own four-wheel drive vehicle, meet at the Visitor Information Station below the summit, and join a vehicle caravan up the road to the top.

After a few hours of touring observatories and scouting photo locations, I parked my rented Jeep at a spot that offered a commanding view of the peak near a small utility building next to the United Kingdom Infrared Telescope. I unloaded my equipment (a tripod, a backpack with cameras, lenses, film, and a pair of 11x80 binoculars) and then pointed the vehicle toward the road so I wouldn't have to back up in the dark. I was near a steep drop-off and did not want to blunder off the edge in the darkness.

I marveled at the environment. It is devoid of plant life. The air is extremely dry; the daytime sky is a dark blue and the earth is rusty brown. Take away the domes, and this could be Mars.



▲ **The Big Dipper Rises over Mauna Kea, Hawaii**

ERNIE MASTROIANNI

(24mm lens at f/2.8, Ektapress 800 film, 1-minute exposure taken April 18, 1998)

▶ **Leonid Meteors in Arizona**

JOSHUA VAUGHAN

(35mm lens at f/2.8, Fuji 800 ISO film, taken November 17, 1998)

◀ **Canopus over Mauna Kea**

ERNIE MASTROIANNI

(24mm lens at f/2.8, Ektapress 800 film, 2-minute exposure taken April 18, 1998)

The domes of the James Clark Maxwell Telescope and Caltech Submillimeter Observatory opened, exposing their dishes. Behind me, I heard low-pitched motors as the dome slit of the U.K. Infrared Telescope opened. As the dome turned, a lower pitch was heard. Then a third sound, a higher whirring, was heard as the the telescope visibly slewed.

To the north, east, and south, the sky was the darkest I had ever seen, and twilight had not ended. Constellations were nearly unrecognizable to this Midwestern observer accustomed to dew-laden skies and omnipresest light pollution. The Milky Way dominated, hanging low in the south and extending west above Canopus and into Orion. Near the horizon, stars lost none of their luster, except in the west, where the zodiacal light glowed in a parabolic arc over the Keck domes.

I mounted the 11x80 binoculars on the tripod. My first target was the Orion Nebula. Its entire extent was easily visible and it looked like an overexposed picture.

I swept the southern Milky Way, looking at knots of nebulae in the richest star fields I had ever seen. But it was unfamiliar. Any effort to correlate what I was seeing with my star charts was too difficult. I was shivering cold and my atlas was open to pages I hadn't used. Only later did I realize that I had seen the Eta Carinae Nebula for the first time.

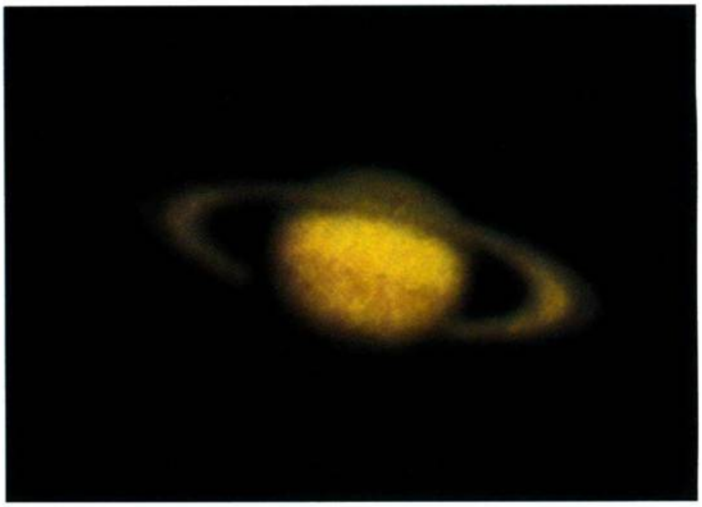
I had spent 7 hours at the peak. It was time to go. A dream had come true.

Ernie Mastroianni is a photo editor at the Milwaukee Journal Sentinel.

Sagittarius Dwarf Galaxy

MARTIN C. GERMANO

(14.5-inch f/5 reflector, hypered Tech Pan film, 170-minute exposure)



Saturn's Orange Globe

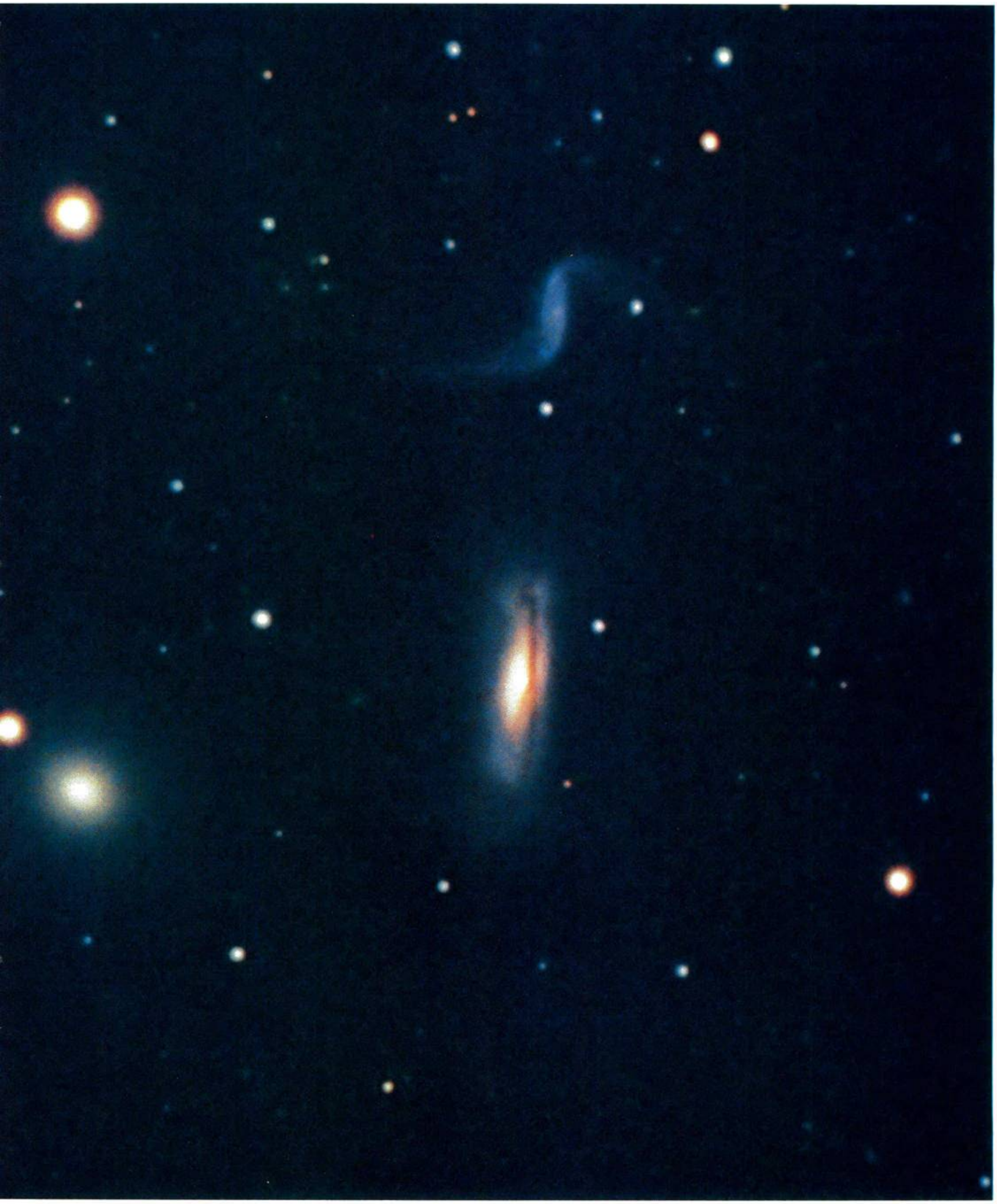
TOM ENDEMANN

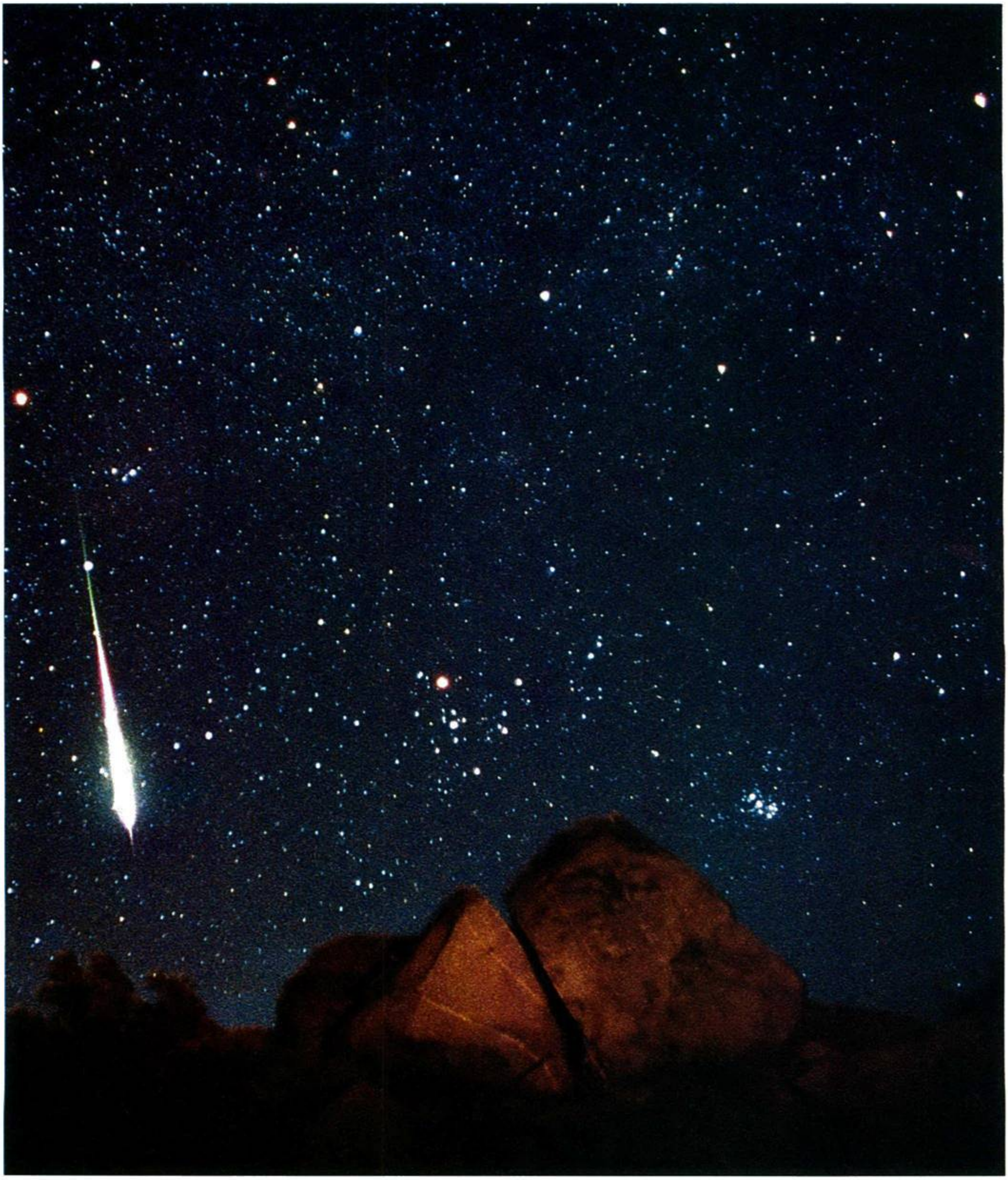
(8-inch scope at f/70, Sensia 100 film, 2-second exposure taken September 16, 1998)

The NGC 3190 Galaxy Group

JAMES R. FOSTER

(14-inch f/11 SCT, hypered Fuji HG 400 film, composite of 120-minute and 90-minute exposures)

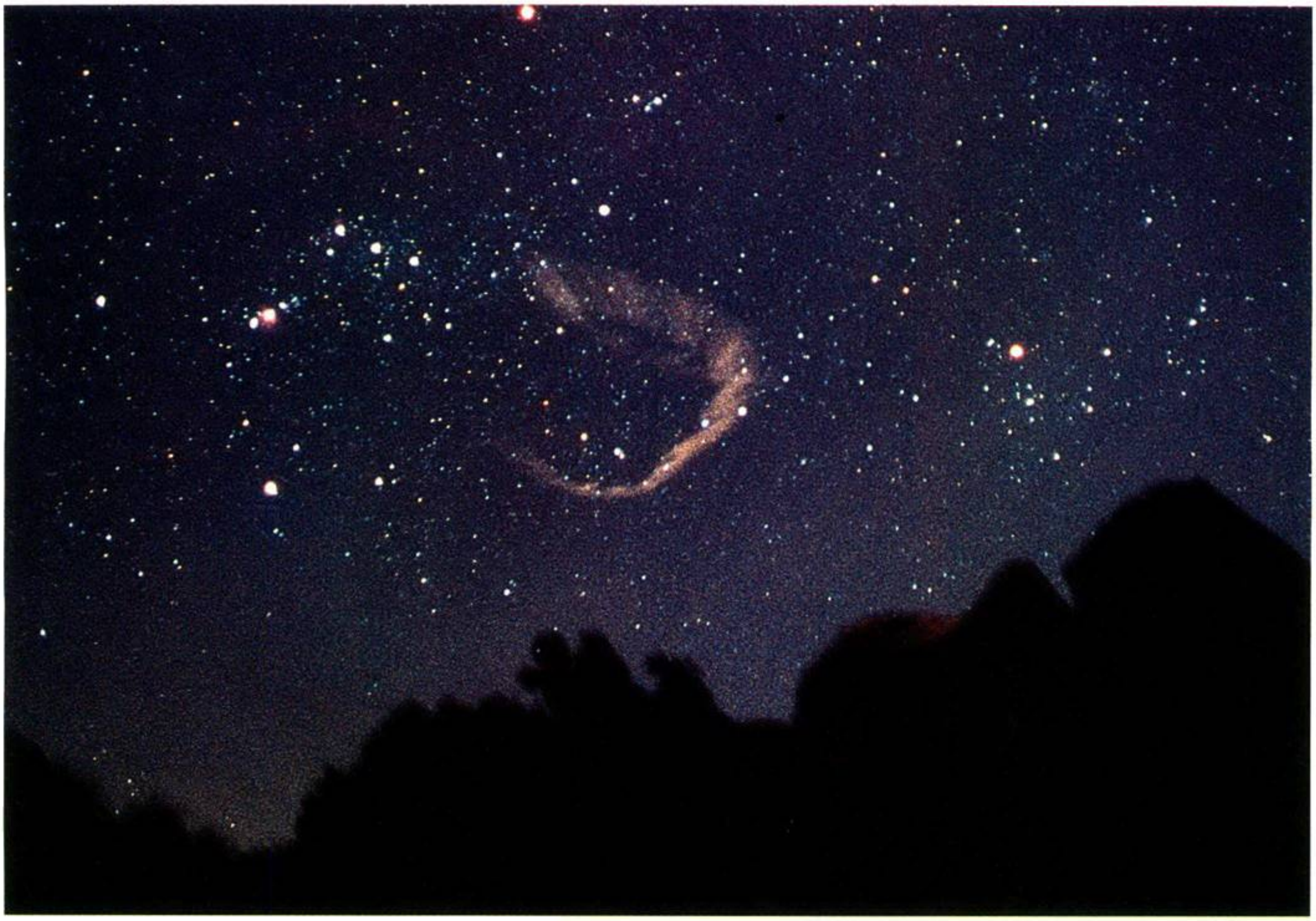




Leonid Fireball Blazes across California's Anza-Borrego Desert

JERRY SCHAD

(24mm lens at f/1.7, P1600 film pushed to ISO 3200, 2-minute exposure taken November 17, 1998)



Disappearing Meteor Train over the Anza-Borrego Desert

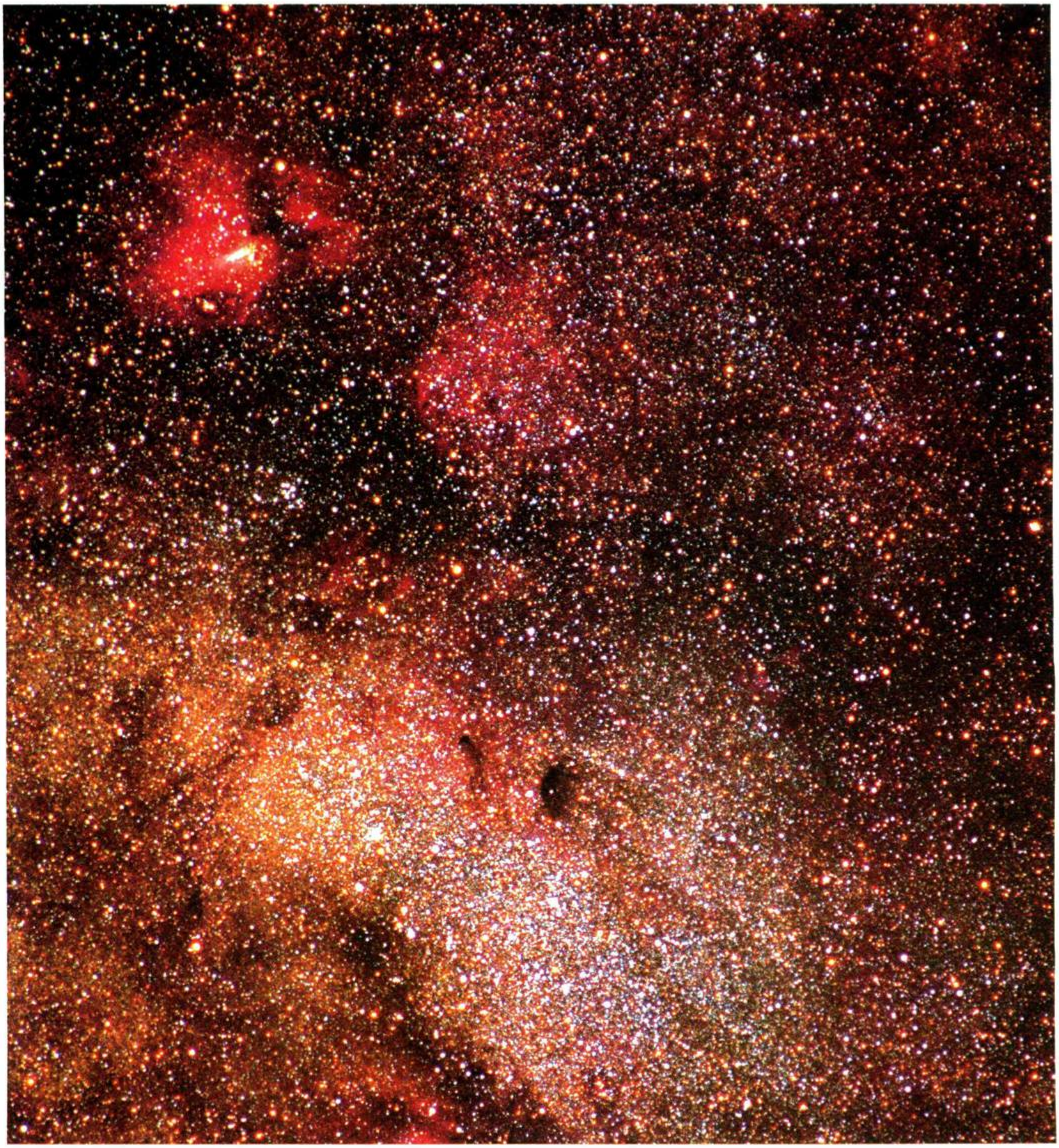
JERRY SCHAD

(taken six minutes after the meteor on the opposite page appeared)

Jupiter's Ocher Globe

ROBERT G. LEVITT

This month's best astrophoto



Summer Milky Way Star Clouds

MICHAEL STECKER

(300mm lens at f/5.6, hypered Kodak Pro PPF film, 40-minute exposure)

The summer Milky Way holds such treasures as the Small Sagittarius Star Cloud (bottom) and the emission nebula M17 (top left).

Tele Vue® Dealers

VISIT THE
Tele Vue® WEB SITE
http://www.televue.com

ARIZONA

The Astronomy Shoppe
YOUR LOCAL Tele Vue® DEALER
3202 Greenway Rd., Suite 1615
Phoenix, AZ 85032
602-971-3170

CALIFORNIA

Tele Vue® Optics Specialists!
OPT Oceanside Photo & Telescope
1024 Mission Ave.,
Oceanside, CA 92054
800-483-6287 • email: opt@optcorp.com
(760) 722-3348 • http://www.optcorp.com

Complete Line of Quality
Tele Vue® Products
Scope City
World's Largest Centers - EXPERT HELP.
Mail order: P.O. Box 440, Simi Valley, CA 93062
TEL: (805) 522-6670 • Fax: (805) 582-0292
Catalog Package $7 (refundable with purchase). Free price list.

NEW STORE

SIMI VALLEY, CA
730 Easy St.
Simi Valley, CA 93065
TEL:(805) 522-6646

COSTA MESA, CA
COSTA MESA, CA
3033 S. Bristol
TEL:(714) 957-6900

SHERMAN OAKS, CA
14324 Ventura Blvd.
TEL:(818) 789-5805

LAS VEGAS, NV
4825 W. Flamingo Rd.
TEL:(702) 947-2673

SAN DIEGO, CA
4766 Clairemont
Mesa Blvd.
TEL:(619) 277-6686

BUY • SELL • TRADE • SERVICE
www.scopecity.com

Tele Vue® NAGLER™

4.8mm - 1¼"	$175
7mm - 1¼"	$220
9mm - 1¼"/2"	$240
12mm - 1¼"/2"	$285
16mm - 1¼"/2"	$310
20mm - 2"	$395

82° Field Spoils You!
LUMICON
2111 Research Dr. #4-5
Livermore, CA 94550
1-800-767-9576

WOODLAND HILLS CAMERA
FEATURING Tele Vue®
Eyepieces, Spotting Scopes, and Telescopes
at low, low prices!
Complete line in stock with excellent service.
Toll Free for Orders: 888-427-8766
Information: 818-347-2270 • Fax: 818-992-4486
5348 Topanga Canyon Blvd., Woodland Hills, CA 91364
BUY SELL TRADE

GEORGIA

Atlanta's Leading Tele Vue® Telescope and Eyepiece Dealer. We Ship Practically Anywhere.
Camera Bug Ltd.
1799 Briarcliff Rd. • Atlanta, GA 30306
(404) 873-4513 • FAX (404) 873-3925
ORDERS ONLY 800-545-8509
www.camerabug.com

MASSACHUSETTS

Hunt's Photo & Video Est. 1889
100 Main St., MELROSE, MA 02176
Call for Astronomical savings on Tele Vue®
1-800-924-8682

MASSACHUSETTS

If you're looking for New England's oldest, most experienced Tele Vue® dealer, you've found it.

- Most Tele Vue scopes, accessories, and eyepieces in stock
- Antique optics
- Used equipment
- Trade-ins
- 78 years of experience
- Boston showroom
- Helpful staff
- Low prices
- Rental equipment
- Order by mail or phone

F. C. Meichsner Co., Inc.
182 Lincoln Street, Boston, MA 02111
(800) 321-VIEW! (8439)

NEVADA/PENNSYLVANIA

AMATEUR ASTRONOMERS...
VISIT EITHER OF OUR TWO FULLY STOCKED SHOWROOMS AND SEE THE COMPLETE Tele Vue® LINE ON DISPLAY !

We display and stock Tele Vue-*101*, Nagler™ Plössl, and Ranger.

We ship everywhere and welcome mail and phone orders.

✱Two showrooms to better serve you.✱

Pocono Mountain Optics
104 NP 502 Plaza
Moscow, PA 18444
Orders: (800) 569-4323
Info: (717) 842-1500
Fax: (717) 842-8364
E-mail us at:
pocmtnop@ptdprolog.net

Pocono West Optics
2580 S. Decatur #3
Las Vegas, NV 89102
Orders: (800) 635-3607
Info: (702) 252-7200
Fax: (702) 252-7130
E-mail us at:
poconowest@aol.com

poconowest@bigplanet.com
Specials of the month: 2.5x and 5x Powermate
Mention this ad for a special price.
See our ad on pages 88 & 89

NEW HAMPSHIRE

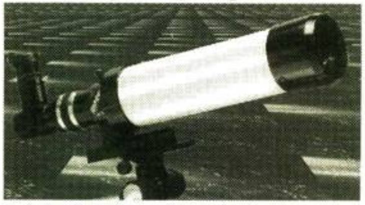
All Tele Vue® Eyepieces In Stock.
Rivers CAMERA SHOP
Personalized Service Since 1930
NO SALES TAX
454 Central ave. Dover NH 03820
(800) 245-7963

NORTH CAROLINA

Your quality Tele Vue® dealer in North Carolina
CC Sales / Camera Corner
Phone: 1-800-868-2462
Fax: (336) 222-8011
2273 S. Church St., Burlington, NC 27215
email: sky@camcor.com • www.camcor.com

NEW YORK

ADORAMA
42 West 18th Street • New York, NY 10011
ORDER TOLL FREE 800-223-2500
ORDERS & INFO 212-647-9800
FAX # 212-463-7223
Our Sales staff, dedicated to astronomy can help with your purchase



Tele Vue®
Full line of TeleVue eyepieces and telescopes in stock and on display including the new Ranger.
ADORAMA

focus Camera & Video
905 McDonald Ave., Brooklyn, N.Y. 11218
800-221-0628 · 718-437-8810
Fax: 718-437-8811
Tele Vue® "Tops in the Field"
Ranger 70mm ED SCOPE
Avail. in Ivory Brass or Green.
The complete Line of Tele Vue® Telescopes & Eyepieces in Stock!

TEXAS

Analytical Scientific™
"The Source For All Your Astronomy Needs"
A whole new way to explore the Universe
AUTHORIZED Tele Vue® DEALER
11049 Bandera Rd., San Antonio, TX 78250
Info: (210) 684-7373 • fax: (210) 520-3344
Toll Free Order Line: 1-800-701-STAR (7827)
http://www.analyticalsci.com

WASHINGTON

Anacortes Telescope & Wild Bird
3202 Commercial Avenue
Anacortes, WA 98221
PH (360) 588-9000
FX (360) 588-9100
http://www.buytelescopes.com
We stock every Tele Vue® product.

Captain's Nautical Supplies
-EST. 1897-
Complete line of Tele Vue® telescopes and eyepieces.
Expert optical instrument repair.
2500 15th Avenue W.
(1 mile South of the Ballard Bridge)
Seattle, WA 98119
Phone: (206) 283-7242 • 1-800-448-2278
FAX: (206) 281-4921

WISCONSIN

Eagle Optics®
Complete selection of
Tele Vue®
eyepieces & telescopes
shipping nationwide
2120 W. Greenview Dr. #4
Middleton, WI 53562
(800) 289-1132 FAX (608) 836-4416
http://www.eagleoptics.com

The best to you, from Tele Vue!

NAGLER

82° — "Space out" with Al

The "spacewalk" eyepiece! Patented & tested to be the best! Fully multi-coated, eyeguards. 20, 16, 12, 9, 7, 4.8mm

NEW! 2.5X POWERMATE

Look Out-They're Multiplying

The 2.5X Powermate joins the original 5x in an aberration controlled powerfest! NEW 4-ELEMENT CONCEPT allows full-field sharpness in a parfocal package. Powermate is even parfocal in 1¼" diagonals.

2.5X POWERMATE™
TELE VUE 5X POWER

Of course, Tele Vue touches such as full multi-coating, captive lock screw and 100% Q.C. at f/4 ensure your satisfaction. Call your favorite Tele Vue dealer TODAY and get powered up tonight!

RICH FIELD KIT

SCT owners—Get Rich Quick!

No gimmicks. Maintain the optical integrity of your scope and increase its field area by 3 times with our Rich Field Kit. The kit includes adapters, 2" diagonal and 55mm Plössl for maximum true field. Use the 35mm Pan. & 20mm N2 too!

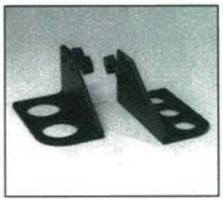
PANOPTIC

68° — aka "Nagler-lite"

Tack-sharpness and exceptional contrast fill your field! 68 deep sky degrees and fully multi-coated. 35, 27, 22, 19 & 15mm

NEW! EYEPIECE CADDY

Eyepieces ride in Caddy Style



Don't chance your eyepieces rolling off a mount tray. Caddy 'em! So simple, so functional, so neat! The Eyepiece Caddy set holds 3, 1¼" and 2, 2" eyepieces at your fingertips. Fits the yoke arms of any Tele Vue Alt-Az head. Incl. 1¼" inserts for 2" holes.

NEW! BINO VUE

Twice is Nice for Newtonians

Bino Vue now has an optimized 2x, parfocal image amplifier for three times more field area. Great for all scope types. Bino Vue has no focus shift during inter-ocular adjustment, large multi-coated prisms and Tele Vue quality.

FINDER

Didn't Know She's Missing

Star-hop across the sky with Starbeam and Qwik-Point "red-dot" finders. Starbeam features a large 40mm lens, variable brightness, elegant design and all metal construction. Qwik-Point offers day & variable night brightness, light weight & exceptional value.

PLÖSSL

50°- Mr. P Would be Proud

Preferred Plössl in S&T comparison review. Fully multi-coated, patented Nagler design. 55, 40, 32, 25, 20, 15, 11, 8mm

NEW! TELE-POD

Earth & Sky Travel Tripod

This 7lb. tripod is for those on the go! Perfect for Pronto and Ranger. We've created a new yoke & cradle head with built-in azimuth bearing, and combined it with aluminum legs for a great mix of stability and portability. The Alt/Az head also fits any standard photo tripod.

24mm - 8mm ZoOOM

Not for the birds anymore!

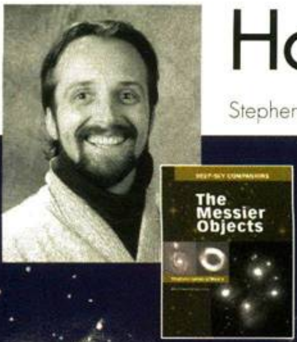
Once solely considered as a birder accessory, the zoom permits an amateur astronomer to tune for optimal exit-pupil size (brightness vs power). Sharp 40° to 55° field, 20mm to 15mm of eye-relief and, of course, 100% Tele Vue quality control. Ideal power ranges with TVO scopes and 2.5x Powermate.

For the past 20 years Tele Vue has proudly offered quality astronomical equipment to amateur astronomers. Design revolutions: "Nagler" eyepieces, true Multi-Purpose telescopes and now Powermate to name a few, combine with exceptional quality control and knowledgeable service to create an ownership experience "...even better than you imagined."

Tele Vue® Dept A, 100 Route 59, Suffern, NY 10901 (914) 357-9522 www.televue.com, literature $3

How a leading expert chose Tele Vue

Stephen James O'Meara, author, Sky & Telescope editor and first to visually recover Halley's comet. Drawings by Stephen James O'Meara



TELE VUE® 10MM
Tele Vue

Tele Vue Telescopes. "Imagination Limited" Observing.

Tele Vue refractors are always ready, willing and able observing buddies. When Stephen O'Meara made the sketches for his book The Messier Objects, he spent long hours with his own, older Tele Vue 4" scope. He writes; *"I had no hesitation in choosing the Genesis. The optics are of unquestionable quality. When coupled with Tele Vue eyepieces (equally revolutionary designs), the Genesis transcends the traditional limitations of long-focus and rich-field refractors, combining the best qualities of both. Genesis and I met serendipitously under dark Texas skies, where I realized its quality and potential. The rest is history."* Stephen discovered a primary virtue of all Tele Vue scopes - versatile performance. Take one along for "imagination limited" observing.

Tele Vue 101: flat field APO, f/5.4

Tele Vue 85: APO, f/7.0

Pronto: 70mm ED, f/6.8

Ranger: 70mm ED, f/6.8

Tele Vue® Dept A, 100 Route 59, Suffern, NY 10901 (914) 357-9522 www.televue.com

The Lagoon Nebula (M8) in Sagittarius. Photographed with a Meade 10" f/10 LX200 Schmidt-Cassegrain Telescope in southern France by Philip Perkins of Wiltshire, England. Mr. Perkins used two exposures of 80-mins. and 85-mins. on hypered Kodak Ektapress Multispeed PJM-2 film; the negatives were scanned and then digitally stacked to form the final image.

The largest-selling telescopes in the world.

ADVANCED PRODUCTS DIVISION
Meade Instruments Corporation
6001 Oak Canyon, Irvine, California 92620 ■ (949) 451-1450
FAX: (949) 451-1460 ■ *www.meade.com*
© 1999